

THE
JOURNAL OF
CONCHOLOGY

(Founded 1874)

BEING THE ORGAN OF THE
CONCHOLOGICAL SOCIETY
OF
GREAT BRITAIN AND IRELAND

EDITED, UNDER THE DIRECTION OF THE COUNCIL

BY

R. C. PREECE, B.SC., PH.D., D.PHIL.

VOLUME 34

1991–1994

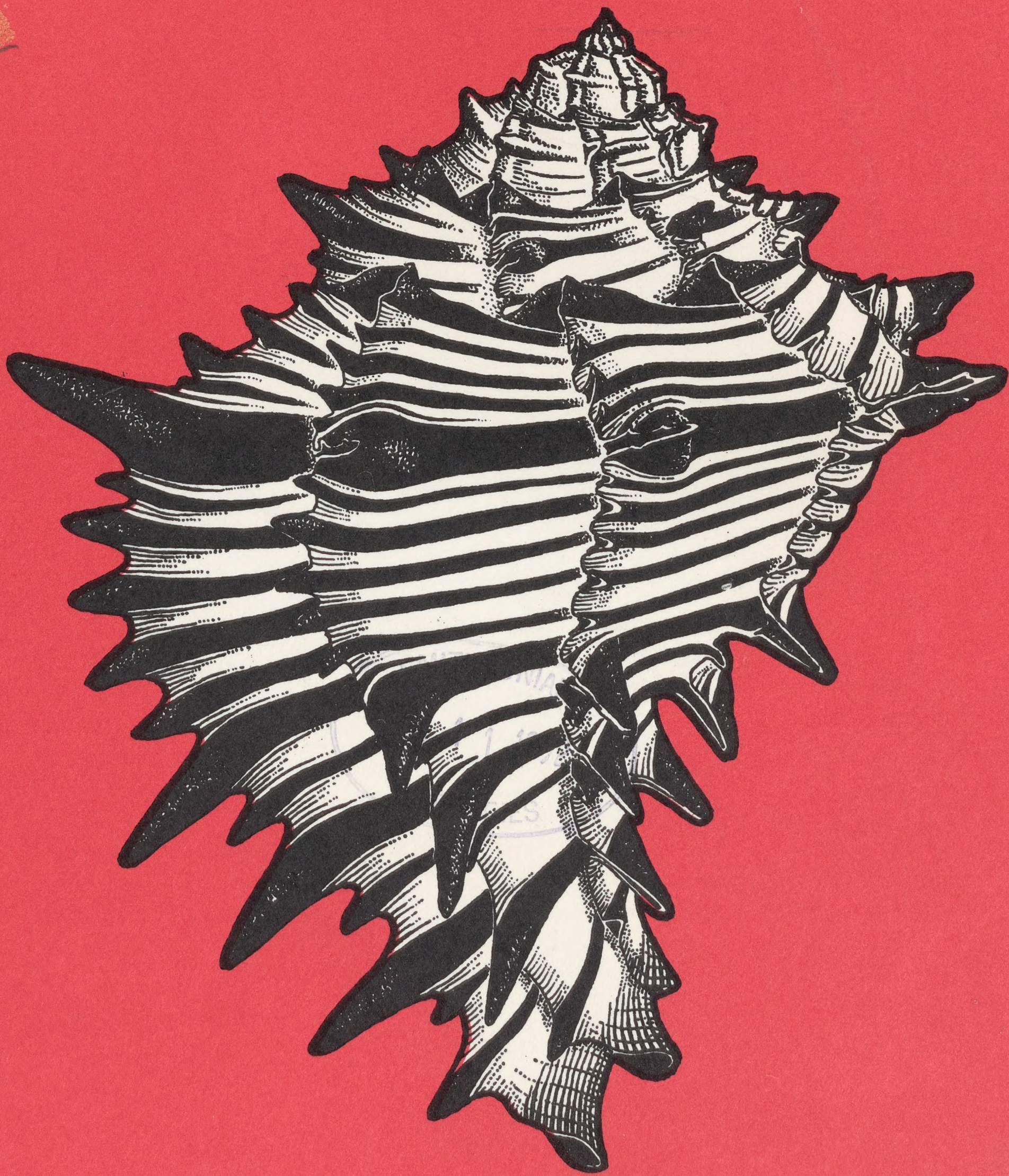
Journal of Conchology

Vol. 34, Part 2

ISSN 0022-0019

January 1992

QL
401
X15
MOLL



**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN
AND IRELAND**

51 Wychwood Avenue, Luton, Bedfordshire LU2 7HT

Hon. Treasurer: Mr. A. SECCOMBE,
36a Selborne Road, Ilford, Essex IG1 3AJ

Hon. Editor: Dr. R. C. PREECE,
Department of Zoology, University of Cambridge,
Downing Street, Cambridge CB2 3EJ.

Member's subscription: £21 per annum. **Entrance fee:** £1.

Family membership: £23 per annum.

Institutional membership: £30 per annum.

Students membership: £10

Meetings are held at the British Museum (Natural History) at 2.30 p.m. usually on the third Saturday of each month from October to May. Field Meetings are held in the summer.

Publications: Members receive

The Journal of Conchology (usually two numbers a year).

The Conchologists' Newsletter (quarterly).

For back-numbers of these publications and special numbers please apply to Mr A. Norris, Leeds City Museum, Municipal Buildings, Leeds LS1 3AA.

Programme Secretary: Mr. I. J. KILLEEN, 163 High Road West, Felixstowe, Suffolk IP11 9BD.

Marine Census Recorder: Mrs. J. LIGHT, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN.

Non-marine Census Recorder: Dr. M. P. KERNEY, Department of Zoology, British Museum (Natural History), London SW7 5BD.

Newsletter Editor: Mr. P. E. NEGUS, 30 Fleetwood Gardens, Market Harborough, Leicestershire LE16 9LX.

COVER DESIGN: *Muricanthus nigratus* (Phillippi) by D. G. Reid.

NOTICE

Payment by Overseas Members

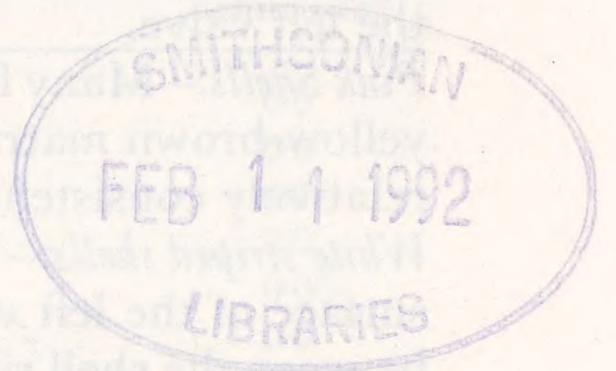
Overseas members are reminded that all monies due to the Society are payable in sterling.

© Conchological Society of Great Britain and Ireland
PHOTOSET BY WILMASET LIMITED, BIRKENHEAD, MERSEYSIDE
PRINTED BY EATON PRESS LIMITED, WALLASEY, MERSEYSIDE

OBSERVATIONS ON SHELL COLOUR IN THE SCALLOP, *PECTEN MAXIMUS* (L.)

DAN MINCHIN¹

(Accepted for publication, 16th March, 1991)



Abstract: Young scallops, less than 15 mm, demonstrate variability of shell colour and of pattern. As growth continues the variations become less pronounced. White shells were the only form studied that showed a consistent pattern to the adult. This form is known to range from the west coast of Ireland southwards to Galicia. Four other colour morphs demonstrated geographic variation within Irish waters.

INTRODUCTION

The full significance of colour variation among bivalve populations is not fully understood, nevertheless great variation of shell colour is known to occur in many scallop species. It is possible that some form of natural selection process is involved as has been demonstrated for the land snail, *Cepaea nemoralis* (L.) (Clarke 1975). Colour variation has also been shown among the complex *Littorina* 'saxatilis' group by Heller (1975), who demonstrated increases of red morphs on Old Red Sandstones. More recently Atkinson & Warwick (1983) have shown that there may be some genetic basis for this phenotypic expression. The scallop *Pecten maximus* (L.) demonstrates a wide variation of colours and patterns and five of these colour forms are described here with some possible explanations as to their occurrence.

METHODS

Adult scallops were collected using traditional dredges or by SCUBA diving. Specimens were aged by the number of rings present on the left (flat) valve, using the technique of Mason (1957). These were recorded as white or non-white shells. Young, 'O' group, scallops of greater than 8 mm shell height were taken from onion bag type collectors and by diving. The colour frequencies were recorded according to the shell colour characteristics described below:

White shells:— No tanning or dark pigment is found on the inner or outer shell surfaces. The outer surface of the left valve is a pale cream-white and slightly translucent, like porcelain. White flèches radiate from the umbone and become more numerous ventrally. This colour can be recognised in adult scallops, although the shells may not always appear white on account of epifaunal and substrate fouling. Occasionally some shells demonstrate the normal features of white shells but also have from one to five narrow red-brown stripes radiating continuously from the umbone of the outer surface of the left valve only.

Brown shells:— These have brown pigment on the outer surface of left and right valves of 'O' group scallops. The brown colouration is uneven, altering in intensity on the shell surface, as well as between individuals. A dark brown area is often near the umbone of the left valve. Some white flèches may or may not be present on the outer surface of the left valve.

¹ Fisheries Research Centre, Department of the Marine, Abbotstown, Dublin 15, Ireland

Brown/Purple shells:— These are pigmented brown but with some purple on 'O' group shells. The brown colour is more intense than in the 'brown' form, in the less intensely pigmented morphs, however the purple pigmentation is always present. Shells can be very dark in colour and colouration of the left valve is normally darker. White flèches may be present on the left valve.

Pink Shells:— Many fine pink striae radiate from the umbone to the ventral margin over a pale yellow-brown matrix on the left valve of 'O' group scallops. Colour intensity appears to be relatively consistent between individuals.

White striped shells:— White gradually flaring lines of varying intensity are found on the outer surface of the left valve radiating from the umbone. The white pigment lines the furrows between the shell ribs. The ribs may be pigmented, if not the shell ribs are opalescent when held to the light. This pattern is often interrupted by anterior-posterior irregular blotched bands, often brown.

RESULTS

Adult scallops with white shells were most frequently encountered on the south-west coast of Ireland, attaining frequencies of almost 5% (Table 1). White shells were not found on the north Irish coast and very few were found within the Irish Sea or off the south-east Irish coast (Fig. 1).

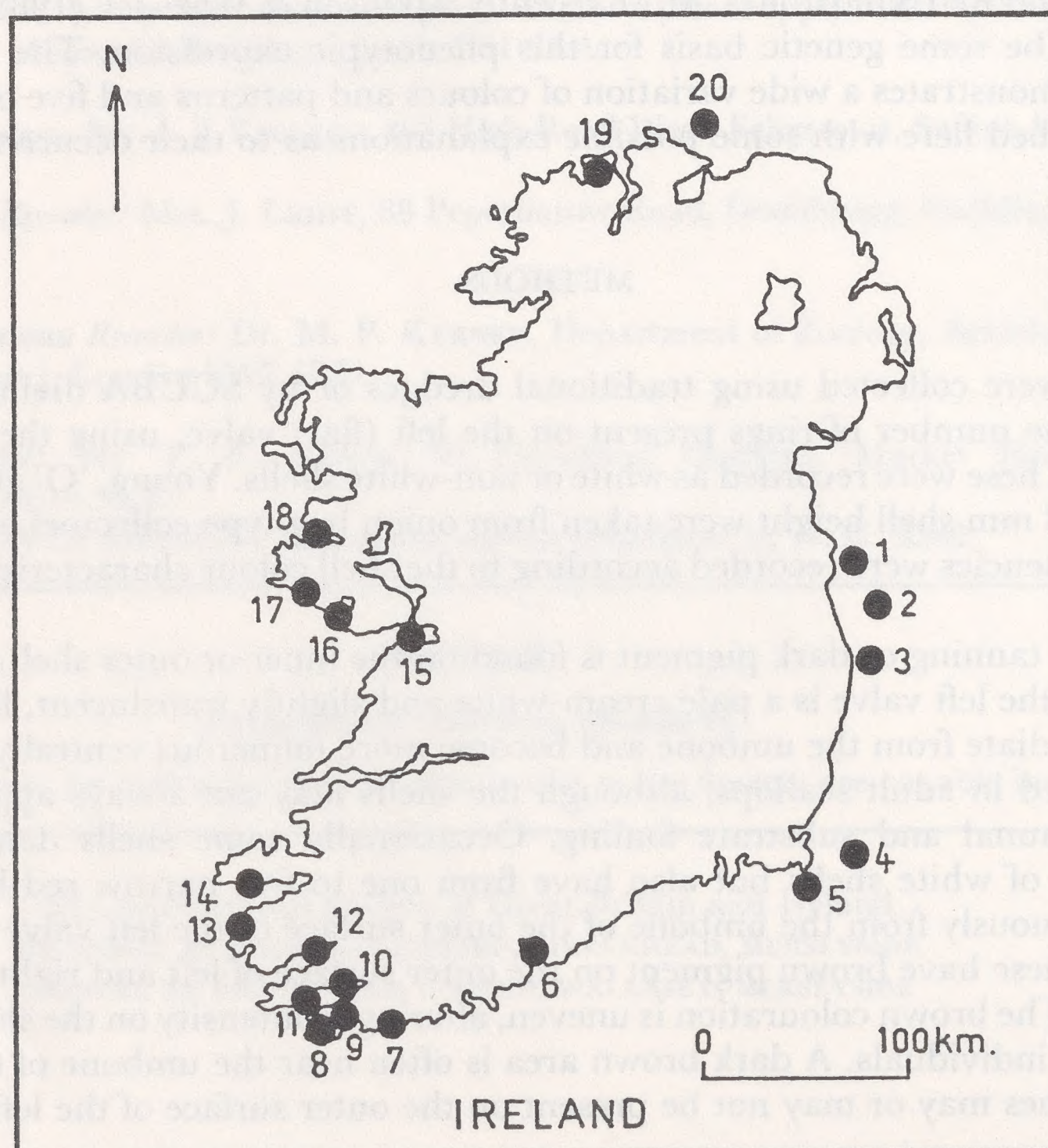


Fig. 1. Distribution of sampling areas for scallops.

TABLE 1

Frequencies of white scallops collected by dredge and by diving (*). The locations are indicated in Figure 1.

Location	Year sampled	Adult sample size	% frequency white shell
1 Lambay Island	'83	212	0.0
2 Kish Bank	'83	97	0.0
3 Bray Head	'76	142	0.0
4 St. George's Channel	'81	159	0.0
5 Saltee	'82	1654	0.06
6 Cork Harbour	'80	144	0.0
7 *Lough Hyne	'78, '81	714	1.4
8 Dunmanus Bay	'81	1074	3.4
9 Whiddy I., Bantry Bay	'77	810	3.4
10 Glengarriff, Bantry Bay	'75	362	4.7
11 Bere Haven, Bantry Bay	'75	1527	3.6
12 Kenmare Bay	'82	816	4.3
13 *Valentia Harbour	'75, '79	825	3.1
14 Dingle Bay	'78	180	4.4
15 Galway Bay	'75	2492	2.2
16 Kilkieran Bay	'74, '75	234	3.0
17 Bertraboy Bay	'74	824	1.9
18 *Killary Harbour	'74	487	1.8
19 *Mulroy Bay	'80-'88	1357	0.0
20 Glengad Head	'75	1478	0.0

The age frequencies of white and non-white scallops taken in commercial tows at Bere Haven and Valentia, on the south-west Irish coast were determined (Table 2). Estimates of total mortality were found to be similar. The oldest white scallop encountered, from Bere Haven, was 12 years.

The frequencies of white 'O' group scallops taken on collectors varied at Lough Hyne between years (Table 3).

The colour frequencies of 'O' group scallops were examined principally at two scallop settlement study sites Lough Hyne on the south coast, and Mulroy Bay on the north coast. Three colour morphs, white, brown, brown/purple were absent from Mulroy Bay (Table 4). Pink and white striped forms were found on collectors from both localities and while diving in Kilkieran.

TABLE 2

Estimates of total mortality for white and non-white scallops in scallop fisheries, assuming constant recruitment.

Number of rings on shell (age)	Valentia Harbour		Bere Haven, Bantry Bay	
	non-white	white	non-white	white
3	184	302	0	0
4	53	113	213	79
5	32	49	157	50
6	10	15	93	39
7	0	0	61	17
Estimate of instantaneous total mortality coefficient (Z)	0.72	0.98	0.43	0.49

TABLE 3

Frequency of white shelled scallops taken on collectors at Lough Hyne.

Year	Collectors laid	sample size	% white shells
1975	early July	874	7.0
1976	mid-July	1546	2.5
1981	mid-July	1630	2.8

TABLE 4

Colour frequencies for three shell morphs of 'O' group scallops taken on collectors.

Locality	sample size	% white	% brown	% brown-purple
Lough Hyne	1630	2.76	4.91	3.07
Mulroy Bay	3421	0.00	0.00	0.00

DISCUSSION

The scallop following settlement grows a thin shell which often appears transparent. As it grows, it develops colours and patterns often vividly contrasting and by 8 mm shell height the described colours are fully apparent. Once shells attain 15–20 mm shell height these colours and patterns usually become less intense. The majority have discarded the byssus by 15 mm shell height and are at this stage usually found recessed in the seafloor with a layer of sediment on the left valve so concealing the colours on the shell. It would appear that the greatest variation of shell colour coincides with the period when they are attached to such supports as algae (Minchin 1984). Selection for certain colours could occur through disruptive patterning and colour matching in relation to the particular substrate type settled on. For example, brown scallops are easily overlooked by divers when attached to the brown kelp *Laminaria saccharina* Lamour.

In most scallops the right valve remains almost unpigmented, even in adults. Scallops normally remain recessed in the sea floor with the right valve facing downwards, and so it is difficult to see selective pressures for colours on the lower valve operating. However, in Brittany the right shell is commonly pigmented with pink and red blotches, this colour form is only rarely seen in Irish waters and then only from the south-east coast. The colouration of the lower valve in Irish waters (south-east coast) and off Brittany is prevalent in areas of strong tidal scouring. It is possible that in areas such as this scallops are frequently overturned and are less conspicuous on account of this pigmentation. Overturned scallops have on occasion been seen but only while diving in areas where there are strong currents.

Thayer (1971) has suggested that many scallop species have a strong selective pressure for crypsis despite their infrequency of swimming. To a diver *P. maximus* often only becomes visible when it starts to swim, and so it is difficult to see how a crypsis in the manner that Thayer portrays is functional. Thayer also states that it is only in deep water that white shelled forms are found. White shelled *P. maximus* have frequently been found in shallow water and some have been recovered at low water spring tide. White shelled *Chlamys varia* L. have been found by the author intertidally in Cashel Bay, Co. Galway.

The white shell is known to occur in the related species *Pecten meridionalis* Tate from Geographe Bay, Western Australia, but is also known in a number of scallop species in the north-Atlantic, *Chlamys tigerina* Müller from Dingle Bay, *Chlamys opercularis* L. from near

Helvick on the southern Irish coast, *Chlamys septemradiata* (Müller) from the Clyde (Allen 1963). It was first described in *P. maximus* by Baird & Gibson (1956), from Bantry Bay. This morph is known also from the coast of Brittany (Quiberon – J. le Dorvan, *pers. comm.*) and from Rias Bajas, Galicia (R. Roman, *pers. comm.*). The white form is not known from Scottish waters (J. Mason, *pers. comm.*). The highest frequencies of this morph in Irish waters were found at Lough Hyne in 1975, a year when 1016 white shelled adults were introduced to Lough Hyne, but were all destroyed by the end of the year. Some of these were spawned under field conditions and the developing embryos and 'D' veliger larvae were released at intervals of some hours to four days, in an attempt to supplement natural spatfall using a possible genetic marker.

The results of the experiment demonstrate a higher frequency of white shells when compared to other years. Laboratory studies demonstrating whether this character is inheritable or not still need to be undertaken.

In a scallop production programme developed by the Centre Oceanologique de Bretagne a preponderance of 'purple' shells were raised in a hatchery (J-C. Dao, *pers. comm.*). Unfortunately no record of parental colouration was documented, nevertheless some genetic process may be implicated. Chanley (1961) has demonstrated shell colour inheritance in the clam *Mercenaria mercenaria* Gmelin, and Innes & Hanley (1977) in the mussel *Mytilus edulis* L. but no reference to shell colour heritability is currently known for scallop species.

White shell forms in *Placopecten magellanicus* (Gmelin) are known in Canadian waters from Newfoundland (S. Naidu, *pers. comm.*) where they are more frequent, attaining as much as 20% of samples examined. Natural colour frequency variations may be of some value in determining the distribution of scallop stocks and it would be extremely valuable to determine whether these characters are heritable or not. Currently transfers of scallop spat have been taking place in European waters since 1982 and should these continue on an extensive scale it is likely that this natural variability may become modified.

ACKNOWLEDGEMENTS

I would like to thank those that dived with me for their assistance in collecting material, as well as those who corresponded information, Dr. C. Moriarty for reading the manuscript and Barbara Minchin for drawing the figure.

REFERENCES

- ALLEN, J. A., 1953. Observations on the epifauna of the deep water muds of the Clyde Sea area, with special reference to *Chlamys septemradiata* (Müller). *J. Anim. Ecol.*, **22**: 240–260.
- ATKINSON, W. D. & WARWICK, T., 1983. The role of selection in the colour polymorphism of *Littorina rudis* Maton and *Littorina arcana* Hannaford – Ellis (Prosobranchia: Littorinidae). *Biol. J. Linn. Soc. Lond.*, **20**: 137–151.
- BAIRD, R. H. & GIBSON, F. A., 1956. Underwater observations on scallop *Pecten maximus* L. beds. *J. mar. biol. Ass. U.K.*, **35**: 555–562.
- CHANLEY, P. E., 1961. Inheritance of shell markings and growth in the hard clam *Venus mercenaria*. *Proc. natn. Shellfish. Ass.*, **50**: 163–169.
- CLARKE, B., 1975. The contribution of ecological genetics to evolutionary theory: detecting the direct effects of natural selection on particular polymorphic loci. *Genetics*, **79**: 101–113.
- HELLER, J., 1975. Visual selection of shell colour in two littoral prosobranchs. *Zool. J. Linn. Soc. Lond.*, **56**: 153–170.
- INNES, D. J. & HANLEY, L. E., 1977. Inheritance of a shell-colour polymorphism in the mussel. *J. Hered.*, **68**: 203–204.

- MASON, J., 1957. The age and growth of the scallop *Pecten maximus* (L.) in Manx waters. *J. mar. biol. Ass. U.K.*, **36**: 473–492.
- MINCHIN, D., 1984. *Aspects of the biology of young scallops, Pecten maximus* (Linnaeus) (Bivalvia: Pectinidae) about the Irish coast. Unpubl. Ph.D. Thesis, University of Dublin. 445 pp.
- THAYER, C. W., 1971. Fish-like crypsis in swimming monomyaria. *Proc. malac. Soc. Lond.*, **39**: 371–375.

SYSTEMATICS AND DISTRIBUTION OF *HELICOPSIS* (*XEROLEUCA*) IN MOROCCO (MOLLUSCA, GASTROPODA: HELICIDAE)¹

M. T. APARICIO², M. B. SEDDON³ AND D. T. HOLYOAK⁴

(Accepted for publication, 22nd April, 1991)

Abstract: There are a considerable number of species described from Morocco which have been assigned to the genus *Xeroleuca*. This survey reviews the status of these and concludes that *Xeroleuca* should be regarded as a subgenus of *Helicopsis*. There are two species present in Morocco; one species *Helicopsis* (*Xeroleuca*) *turcica* is very variable in shell form. The geographical range of *Helicopsis* (*X.*) *turcica* is described and the numerous species names synonymised. Other species originally placed in the genus *Xeroleuca* are found to belong to other genera.

INTRODUCTION

Most of the pulmonate taxa described from NW. Africa are only known from shells, hence their generic classification has been made on the basis of shell characters alone. Previous studies, especially those of Hesse (1934), showed that subdivision in the 'Helicellinae' cannot be securely founded on shell characters due to frequent parallelism and convergence of shell forms. These difficulties, added to by the introduction of a multiplicity of species names by the early workers along with the paucity of papers on Morocco since the 1930's, have greatly hindered taxonomic study of most of the NW. African 'Helicellinae' in recent years.

This paper begins the process of reducing the confusion which exists for NW. African 'Helicellinae' by considering anatomical data for species of *Xeroleuca*. The variability of shell morphology is reviewed in order to rationalise the nomenclature. We concentrate on the taxa that are placed in *Xeroleuca* but we also consider species with similar shells which were formerly referred to this group.

The studies of Schileyko (1973, 1978) have raised the interesting possibility that the traditional helicellinae group of genera are extremely close to those of the Hygrominae as only one character, the position of the right ommatophore retractor muscle, is used to discriminate between these subfamilies. He suggests that all genera from these belong to the same subfamily. Interpretation of the evolution of changes in the distal genitalia are important in considering the possibility of monophyletic or polyphyletic origins for the Helicellinae. These issues have been discussed in recent papers of Giusti & Manganelli (1987, 1989) Manganelli & Giusti (1989, 1990) on Mediterranean Hygromidae and by other workers such as Hausdorf (1990) and Nordsieck (1986, 1987). We discuss the significance of the dart-sac complex of the NW. African *Helicopsis* as there are implications for the understanding of relationships between taxa throughout the Mediterranean region.

¹ Systematics and Biogeography of the Land-Mollusca of NW. Africa; Contribution no. 5.

² Museo Nacional de Ciencias Naturales, Jose Gutierrez Abascal 2, 28006-Madrid, Spain.

³ Dept. of Zoology, National Museum of Wales, Cathays Park, Cardiff, CF1 3NP, U.K.

⁴ Formerly Cheltenham & Gloucester College of Higher Education, Shaftsbury Hall, Cheltenham, U.K. Present address c/o 22 Elm Grove, Watford, Herts., U.K.

HELICOPSIS

(*XEROLEUCA* Kobelt, 1877)

Kobelt, 1877 *Jb. d. malakozool. Ges.*, p. 25.

Helicopsis (Xeroleuca) turcica (Holton, 1802)

Pls. 4a–e, 5a–e, 6a,c,e.

Trochus turcicus Chemnitz, 1795, *Neues Syst. Conchyl. Cab.*, **11**, pp. 280–281, pl. 209, figs. 2065, 2066 (*nomen nudum*).

Helix turcica (Holten, 1802) *Enum. System. Conch.* p. 65 [syn. *cratera* Schumacher by Tryon, 1888 but description not located in the literature hence apparently a *nomen nudum*].

Helix mograbina Morelet, 1852 *J. Conchyl.*, Paris, **3**, pp. 62–64, pl. 1, figs. 11–13. syn. var. *bergeroni*, var. *claveli*, var. *privatiana* Pallary, 1918; *Moghrabina* Pallary, 1918 p. 143 (unjustified emendation); *major*, *minor*, *obtecta* Pallary, 1918.

Helix mogadorensis Bourguignat, 1863, *Moll. Nouv. Litig.*, **3**, p. 57, pl. 9, figs. 1–3.

Leucochroa degenerans Mousson, 1873 *Malakazool. Bl.*, **21**, p. 150. syn. var. *validior* Mousson, 1874; var. *galeola* Pallary, 1913.

Xeroleuca brulardi Pallary, 1913, *Bull. Mus. Hist. nat., Paris*, **19**, pp. 362–363.

Xeroleuca rebiana Pallary, 1913, *Bull. Mus. Hist. nat. Paris*, **19**, pp. 363–364.

Xeroleuca babelis Pallary, 1920, *Bull. Soc. Hist. nat. Afr. Nord*, **11**, p. 27 (p. 12 in offprint).

Xeroleuca chabertiana Pallary, 1923., *Bull. Soc. Hist. nat. Afr. Nord*, **14**, pp. 117–118. syn. *cyclostremoides* Pallary, 1904 (not Sowerby, 1888).

Xeroleuca depressiuscula Pallary, 1936, *J. Conchyl.*, Paris, **80**, p. 15, pl. 2, fig. 11.

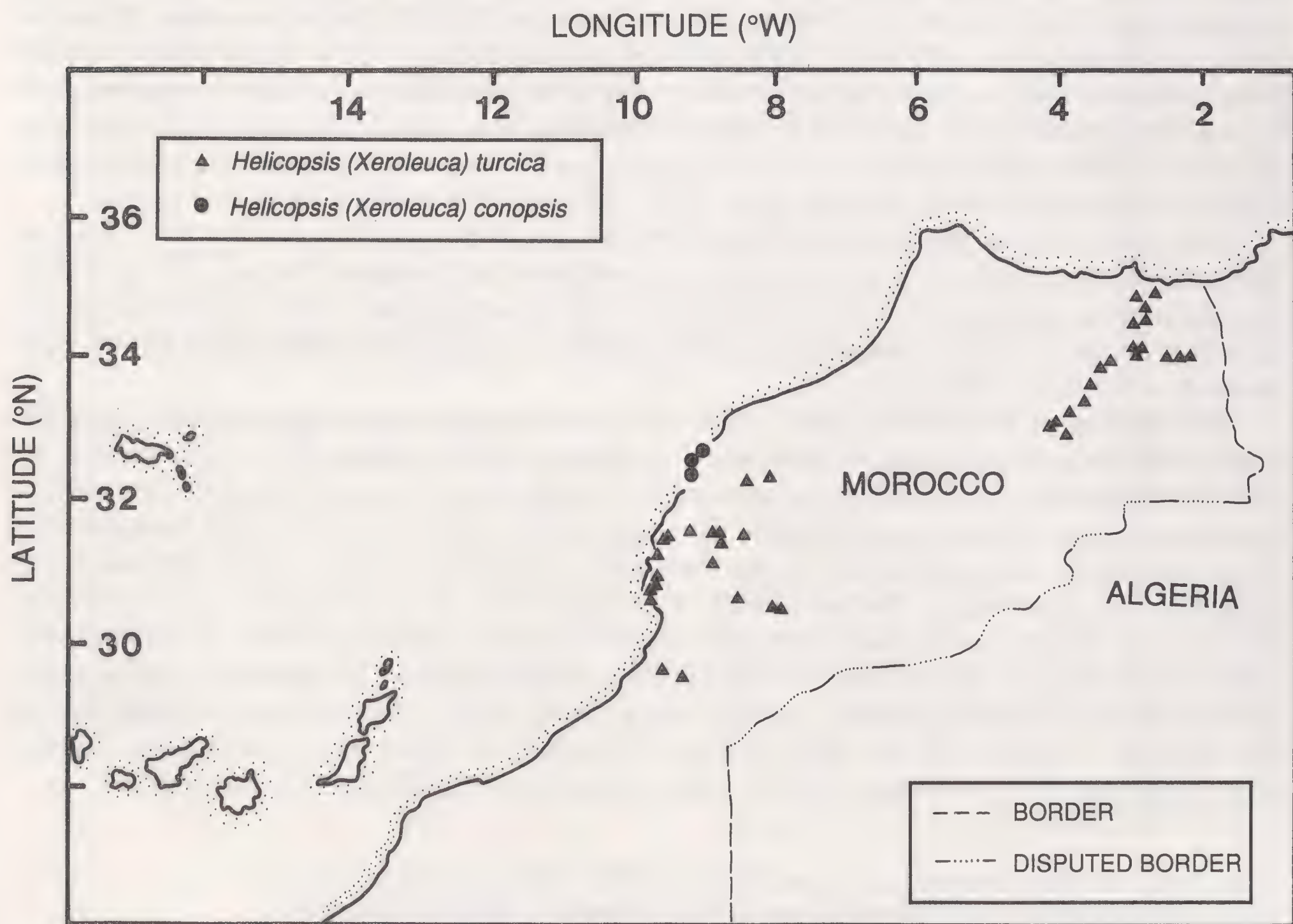


Fig. 1. Map of the distribution of *Helicopsis (Xeroleuca) turcica* and *Helicopsis (Xeroleuca) conopsis* in Morocco. Material from all localities in the collections at the NMWZ.

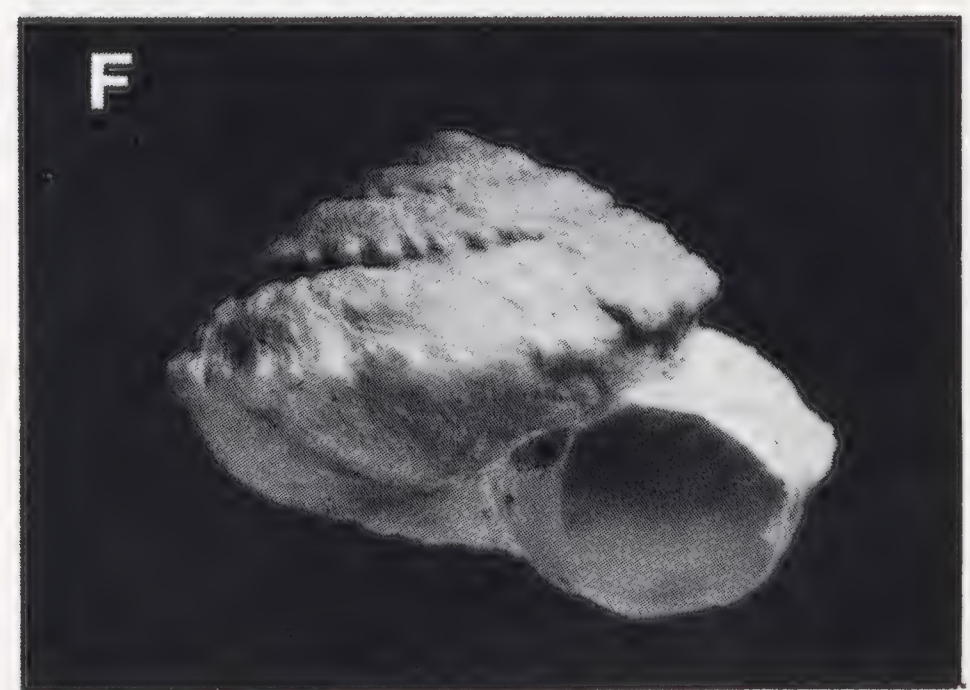
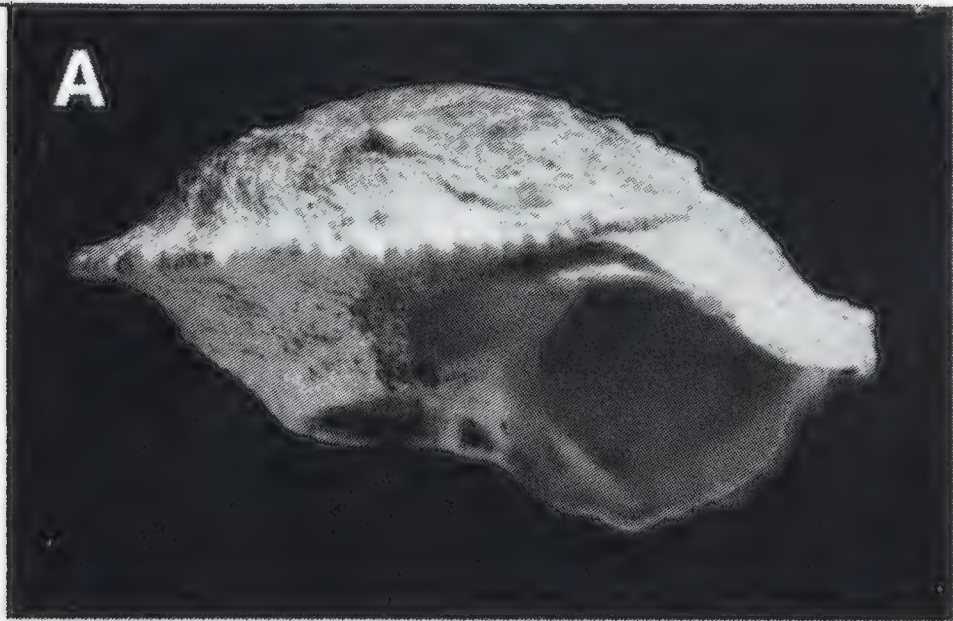


PLATE 4

Helicopsis (X.) turcica a. 1986.159 Taftecht, diameter 18.9 mm; b. 1986.170 Tamanar, diameter 19.1 mm; c. 1986.100 Debdou, diameter 15.8 mm; d. 1986.157 M'Zoudia, diameter 17 mm; e. 1986.428 Fritissa, diameter 19.2 mm; f. 1986.431 Melga-el-Ouidane, diameter 15.2 mm.

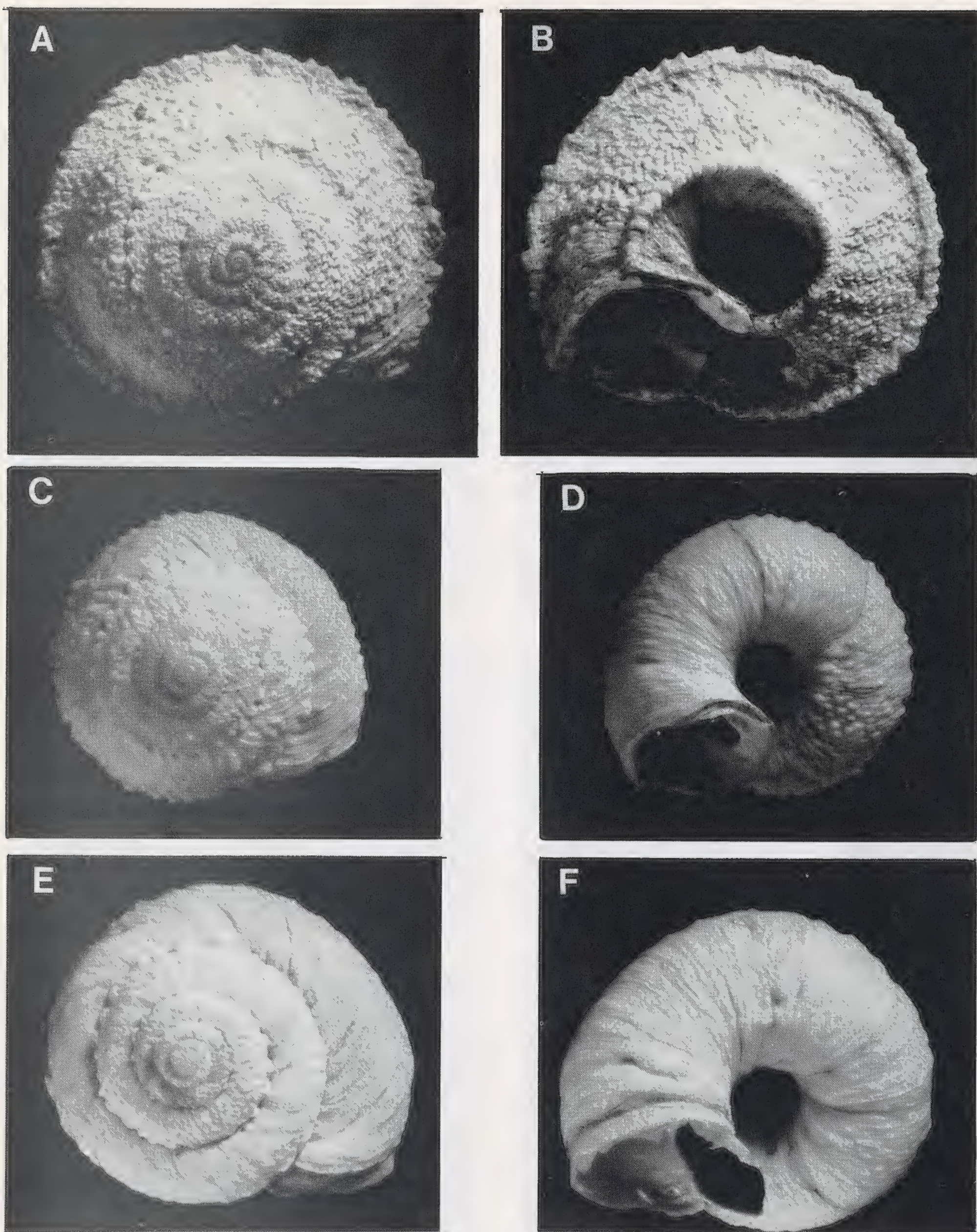
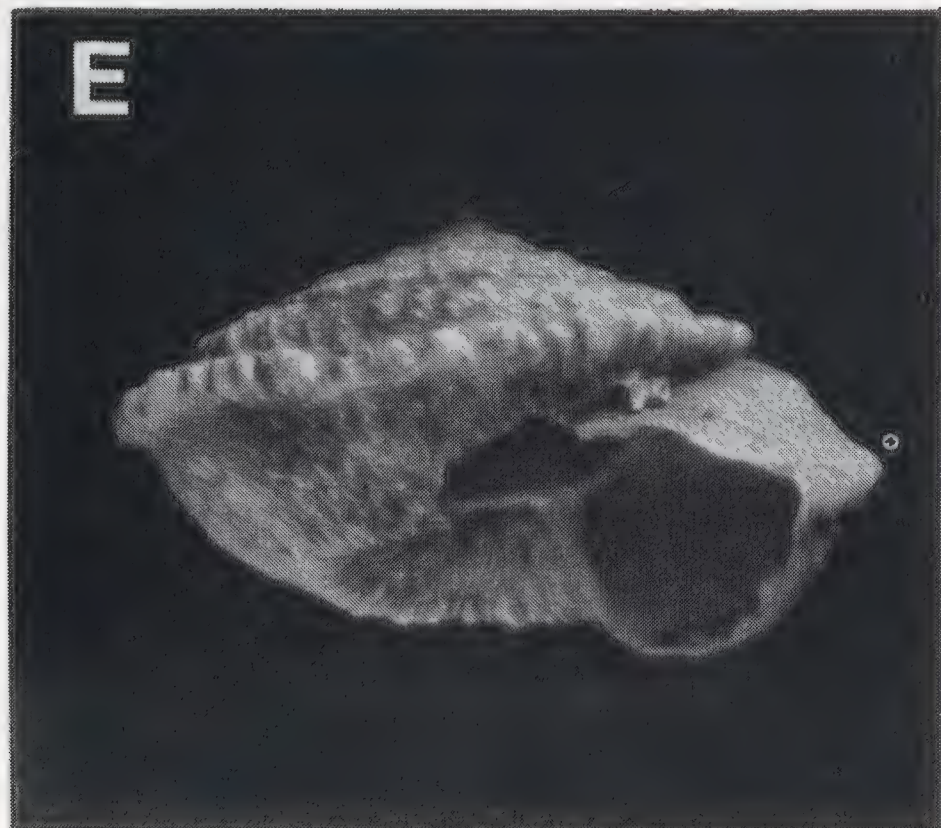
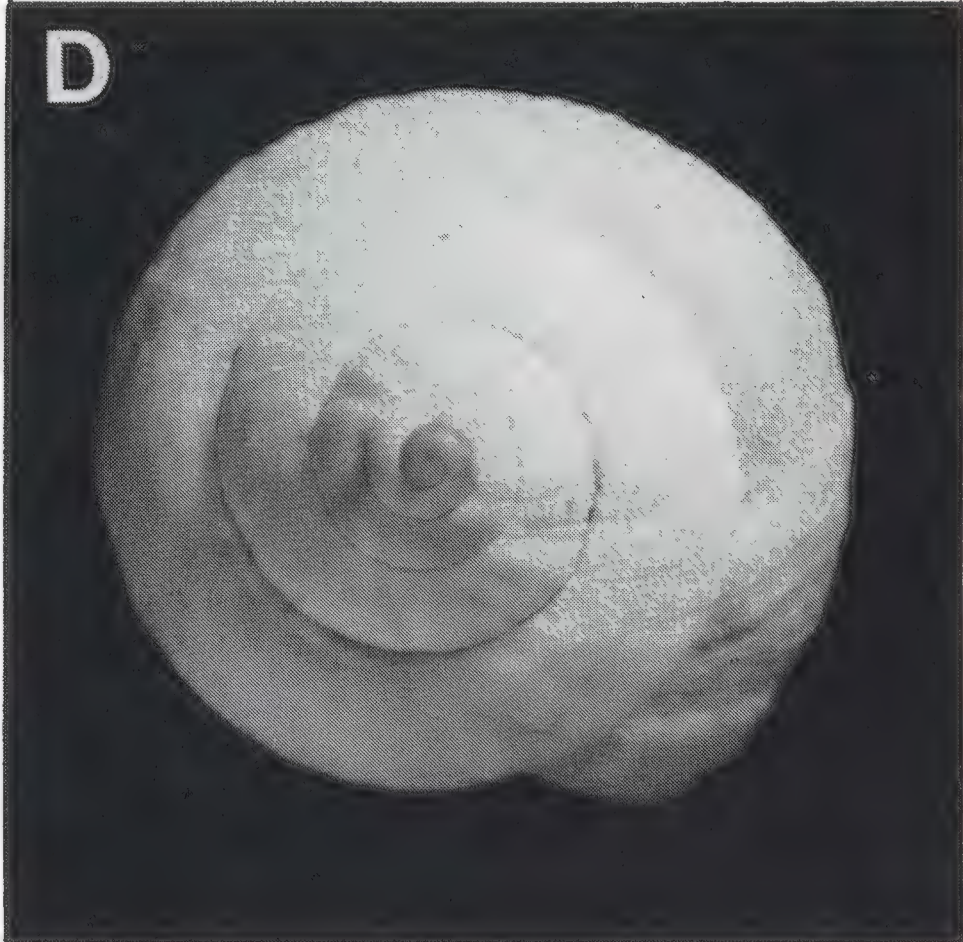
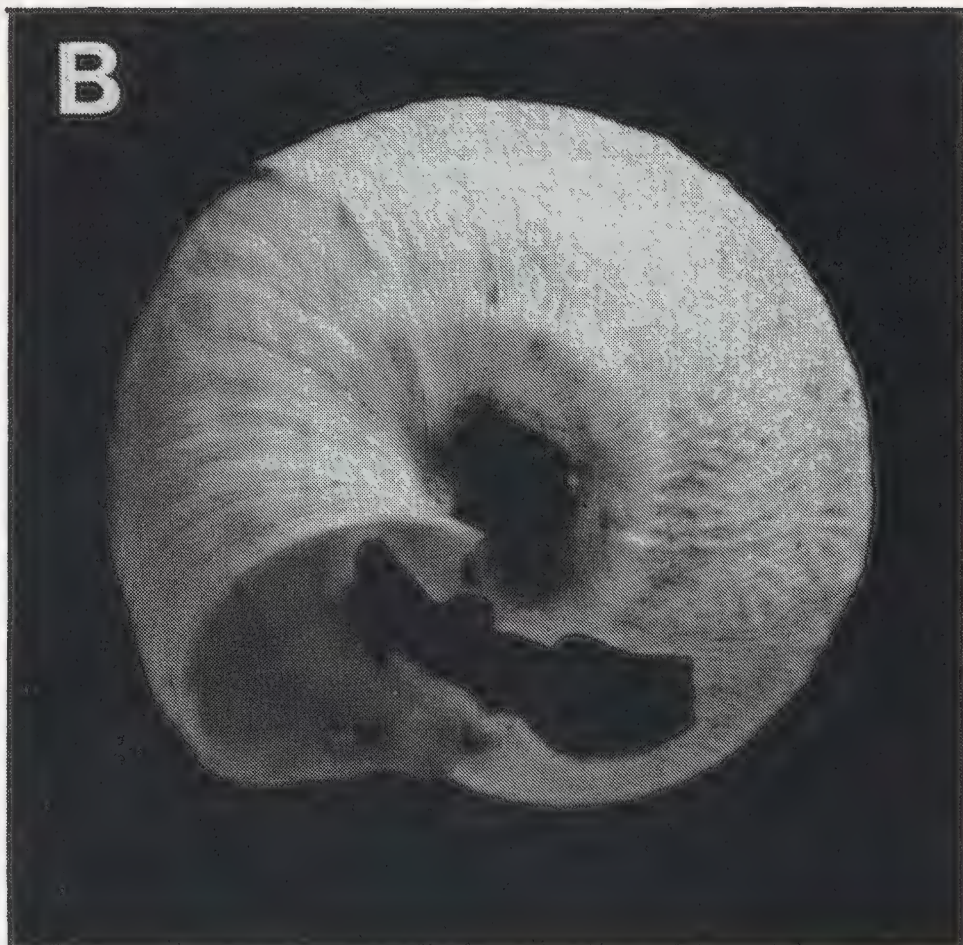
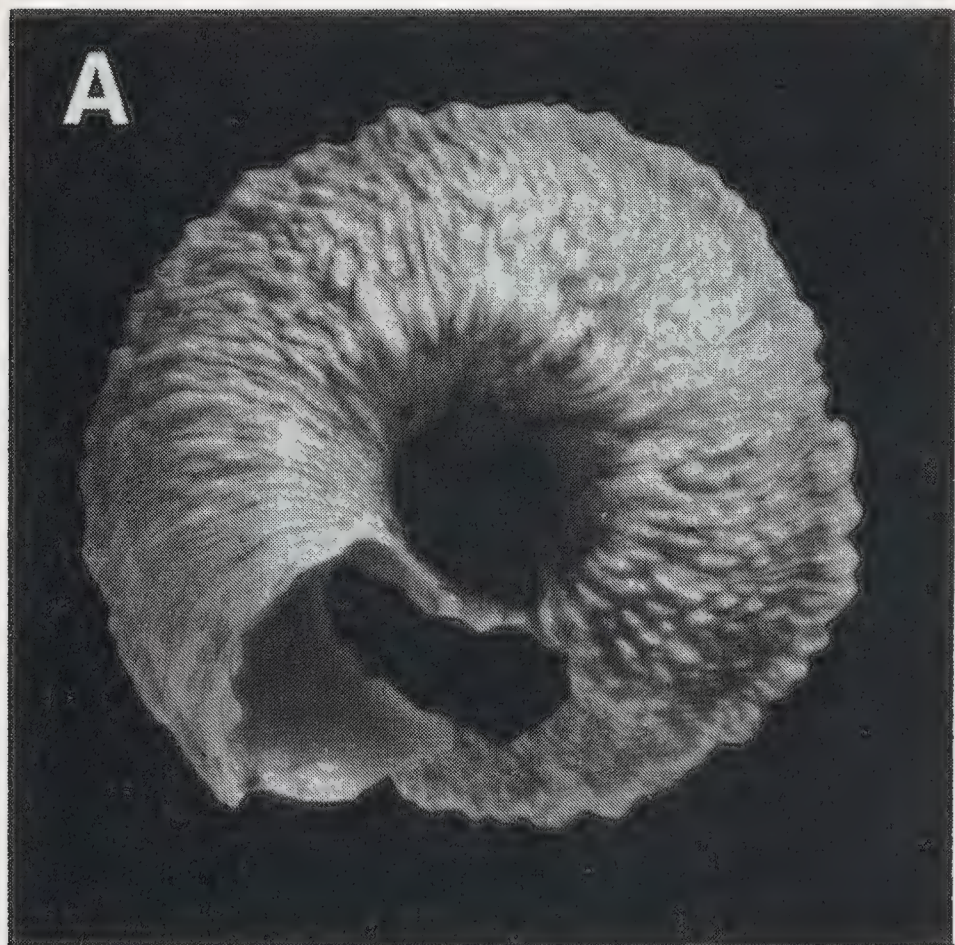


PLATE 5

Helicopsis (X.) turcica a,b. 1986.170 Tamanar; c,d. 1986.100 Debdou, diameter 15.8 mm; e,f 1986.428 Fritissa.

PLATE 6 (opposite)

Helicopsis (X.) turcica a,c,e, 1986.95 Hassi-Berkane, diameter 14.8 mm; *Helicopsis (Xeroleuca) conopsis* b,d,f 1986.277 N. of Safi, diameter 13.4 mm.



Material examined: Material was examined from 42 sites in Morocco (Fig. 1.); specimens from all of these sites, including those dissected, are lodged in the Holyoak & Seddon Collection, National Museum of Wales (NMWZ. 1986. 117 [1984 material]; NMWZ. 1987. 001 [1986 material]). The material selected for study was representative of observed variability of shell form and the extent of its range.

This study included examination of Pallary topotypes (from the Melvill-Tomlin Collection, National Museum of Wales) or our topotypical material. Many of the specimens provided by Pallary in the Melvill-Tomlin Collection could be syntypic, but in the absence of labels confirming this they can only be given as topotypical. Pallary syntypes were available for some species in the collections at the BM(NH). On the basis of examination of topotypical material and our work on the genital anatomy we consider all of the above to be synonyms of one rather variable species, *Helicopsis (Xeroleuca) turcica*.

Shell material additional to data shown in Fig. 1;

Helix turcica (Holten, 1802)

Melvill-Tomlin Colln. (NMWZ. 1955. 158) labelled Mogador (8 specimens).

Xeroleuca mograbina (Morelet, 1852).

Holotype and 2 paratypes, [Morelet] British Museum (Natural History), London (BMNH. 1893.2.4.393–95) Morocco.

Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158); 2 specimens from Ouchda [=Oujda].

Xeroleuca mograbina (Morelet, 1952) var. *bergeroni* Pallary, 1918

Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158). Guettara, NE. Morocco; 3 specimens; topotypes. Connolly Colln. [P. Pallary], British Museum (Natural History), London (BMNH. 1937.12.30.10551–55) 5 shells labelled syntypes but locality given as Mçour.

Xeroleuca mograbina (Morelet, 1852) var. *claveli* Pallary, 1918

Connolly Colln. [P. Pallary], British Museum (Natural History), London (BMNH. 1937.12.30.10543–46) 4 shells, Safsafat, NE. Morocco. Connolly Colln. [P. Pallary], British Museum (Natural History), London (BMNH. 1937.12.30.10547–50) 4 shells, Ain Guettara, NE. Morocco. Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158). Mçour, NE. Morocco; 8 specimens; Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158), Mahiridja, 2 specimens, topotypes.

Xeroleuca mograbina (Morelet, 1852) var. *privatiana* Pallary, 1918

Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158) Taourirt, Morocco; topotypes. Connolly Colln. [P. Pallary], British Museum (Natural History), London (BMNH. 1937.12.30.10594–98) 5 shells labelled syntypes but locality given as Debdou.

Xeroleuca mogadorensis (Bourguignat, 1863) Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158) Marrakech, Morocco; 3 specimens.

Xeroleuca degenerans Mousson, 1873 Melvill-Tomlin Colln. [Rolle] (NMWZ. 1955.158) Mogador, Morocco; 5 specimens.

Xeroleuca degenerans Mousson, 1873 var. *validior* Mousson, 1874; Connolly Colln. [P. Pallary], British Museum (Natural History), London (BMNH. 1937.12.30.10574–77) 4 shells syntypes but locality given as M'tougui. Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158) Ouled les Sba, Morocco; 3 specimens.

Xeroleuca brulardi Pallary, 1913

Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158) Taourirt, Morocco; 3 specimens; topotypes.

Xerophila (Xeroleuca) babelis Pallary, 1920

Melvill-Tomlin Colln. [P. Pallary] (NMWZ. 1955.158) Camp Berteaux; 2 specimens; topotypes.

Xeroleuca depressiuscula Pallary, 1936

Connolly Colln. [P. Pallary], British Museum (Natural History), London (BMNH. 1937.12.30.10591–93) 3 shells, syntypes. Melvill-Tomlin collection (NMWZ. 1955.158) Imouzer d' Agadir, NW. of Agadir, W. Morocco, (3 specimens).

Localities from which specimens from the Holyoak & Seddon Collection were dissected:

Western Region

Taftecht, Morocco, 31°34'N, 9°16'W (HS#1986.159.7), 8 specimens dissected; Tiznit, Morocco, 29°36'N, 9°37'W (HS#1986.182.6), 1 specimen dissected; Chicaoua, Morocco, 31°33'N, 8°50'W (HS#1986.158.7), 1 specimen dissected; M'Zoudia, Morocco, 31°34'N, 8°30'W (HS#1986.157.3), 5 specimens dissected; Ounara, Morocco, 31°30'N, 9°39'W (HS#1986.162.14), 1 specimen dissected; Smimou, Morocco, 31°15'N, 9°43'W (HS 1986.167.13), 1 specimen dissected; Tamanar, Morocco, 30°52'N, 9°45'W (HS#1986.70.9), 1 specimen dissected; Talioune, Morocco, 30°30'N, 7°52'W (HS#1986.362.5), 1 specimen dissected;

Eastern Region

Hassi-Berkane, Morocco, 34°31'N, 2°52'W (HS#1986.95.22), 1 specimen dissected; Debdou, Morocco, 34°04'N, 2°57'W (HS#1986.100.4), 1 specimen dissected; Taourirt, Morocco, 34°33'N, 2°46'W (HS#1986.97.10), 1 specimen dissected; Naima, Morocco, 34°33'N, 2°46'W (HS#1984.372.1), 1 specimen dissected; Missouri, Morocco, 33°12'N, 3°50'W (HS#1986.426.8), 2 specimens dissected; Fritissa, Morocco, 33°37'N, 3°32'W (HS#1986.428.5), 2 specimens dissected; Fritissa, Morocco, 33°51'N, 3°25'W (HS#1986.429.6), 2 specimens dissected; Melga-el-Ouidane, Morocco, 34°29'N, 2°59'W (HS#1986.431.10), 2 specimens dissected;

Shell: The following description applies to all the forms listed above. The rather strong, solid, opaque shell has 4–5.5 whorls. It is generally discoid; the height of the shell varies in different populations giving a shape which varies from almost conical (Plate 4d,e) to flattened discoid (Plate 4a). Although all the shells have a peripheral keel, the extent of the development varies, so that in some populations the shell has a blunt, almost shouldered appearance (Plate 4d), whereas others have a sharp, strongly crenulated keel (Plate 4b). The umbilicus varies from moderately open (Plate 5d,f) to wide and deep (Plate 5b). In some populations the edge of the umbilicus is exaggerated by a raised keel (Plate 5b). The shell is usually pale, ranging from chalky white to light brown. There are coarse granular tubercles on the shell surface giving a roughened appearance (Plate 5a); they are usually present on the peripheral keel giving a puckered appearance to the suture. Some populations have reduced sculpture (Plate 5e), in other populations the tubercles are pronounced in radial lines on the shell (Plate 5f).

Shell measurements: The measurements in Table 1 were made using the method outlined in Kerney & Cameron (1979). The sites selected represent the range of shell variability for *Helicopsis* (*Xeroleuca*) *turcica*.

Genital anatomy: Some of the distal genitalia of material dissected is illustrated in Fig. 2. (A–H, L–N). For the use of anatomical terms see Aparicio and Ramos (1987).

Male organs: the penis is 2.5–5.0 mm long, with a papilla where the central and anterior part of the penis is enlarged. The epiphallus (3–8 mm) varies in length, but is frequently twice the length of the penis. The flagellum (2–3.4 mm) is usually the same length as the penis.

Female organs: there are four clearly distinguishable dart-sacs; their size (1.5–2.5 mm) is proportionately small in relation to the other parts of the genital system (about 3/4 the length of the penis; 1/2 the length of the spermathecae; shorter than the length of the flagellum).

TABLE 1

Shell measurements for populations of *Helicopsis (Xeroleuca) turcica* (Holten, 1802)

Site	No of Shells	Diameter Range (mm)	Mean Diameter (mm)	Standard Deviation	Height Range (mm)	Mean Height (mm)	Standard Deviation
Taftecht (W. Morocco)	30	15.5–19.4	17.68	1.50	7.7–13.2	10.11	1.26
Tiznit (W. Morocco)	22	17.0–22.6	20.30	1.54	7.6–12.6	9.77	1.09
Taliouine (W. Morocco)	30	14.4–18.0	16.46	0.88	9.4–13.2	10.66	0.94
Ounara (W. Morocco)	10	16.0–19.8	17.92	1.31	11.1–11.8	8.36	0.84
Missour (NE. Morocco)	32	14.9–18.4	16.50	0.84	9.5–12.9	11.45	0.85
Fritissa (NE. Morocco)	25	13.5–18.0	15.69	1.16	9.7–13.9	11.61	1.15
Guercif (NE. Morocco)	21	13.1–18.0	15.30	1.09	9.1–13.1	10.96	1.15

The external dart-sacs contain a dart of simple structure whereas the internal pair of sacs do not contain darts. The darts are straight with a slight curve near the end (Fig. 2. L–N). The dart is small (0.4–1.3 mm) and hence does not occupy the inner space available in the dart-sacs. A free-vaginal neck was seen in all the specimens dissected; this varied in length from 0.5 mm to 1.8 mm. Both the distal and proximal parts of the vagina are conspicuous and the vagina can be seen between the dart-sacs. The vaginal mucous glands vary in number from 8 to 15 terminal tubes. The spermathecae is bag-like in shape. The spermathecal duct is long (4.5–8 mm), more than three times the length of the spermathecae.

Range: The range of *Helicopsis (Xeroleuca) turcica* covers two distinct regions (Fig. 1.) separated by the Haute Atlas and the Moyen Atlas. The western region stretches from Marrakech to the Atlantic coast and down to near Tiznit. The species does not get into the Haute Atlas mountains, but is found on the surrounding foothills and the coastal plain. There is also a form which occurs in the intervening higher region between the Haute Atlas and the Anti Atlas; the inland records of this form represent sub-fossil shells although their age is uncertain. The Eastern region stretches from Oujda to Missour to Ain Beni Mathar and up to the Mediterranean coast near Montes de Kbdana and Montes de Beni Snassen.

Ecology: *Helicopsis (Xeroleuca) turcica* is found in a variety of habitats; many sites were at elevations between 200–500 m although sites where it was recorded ranged between 20 m and 1390 m A.S.L. In W. Morocco most of the sites were calcareous sandstone or limestone hillslopes, sometimes with low crags and usually with scattered flat rocks lying on the surface. On the coast adjacent to the Haute Atlas some sites were above sea-cliffs. A few sites were on the limestone plains north of Marrakech. The vegetation was usually composed of scattered herbs and grasses with occasional low bushes. Some of the coastal sites from Cap Rhir southwards had succulent euphorbs present. The sites in E. Morocco were generally calcareous sandstone or conglomerate regions either on plains or on hillslopes. The surface was often silty or sandy rather than rocky. The dominant vegetation cover was herbs with scattered bushes and sparse grasses.

Within these areas *Helicopsis (Xeroleuca) turcica* was commonly found where there were loose stones present on the ground. At these sites living specimens were found aestivating either (a) on the top of the rock in the open or (b) under the rock or on the overhanging sides in the shade. At sites with few large stones specimens were found aestivating on the branches of thorn bushes and occasionally on succulent euphorbs. The keeled specimens were usually found where there were rock crevices or angular boulders which provided holes which they could creep into. These specimens were sometimes more difficult to dislodge than the rounded specimens.

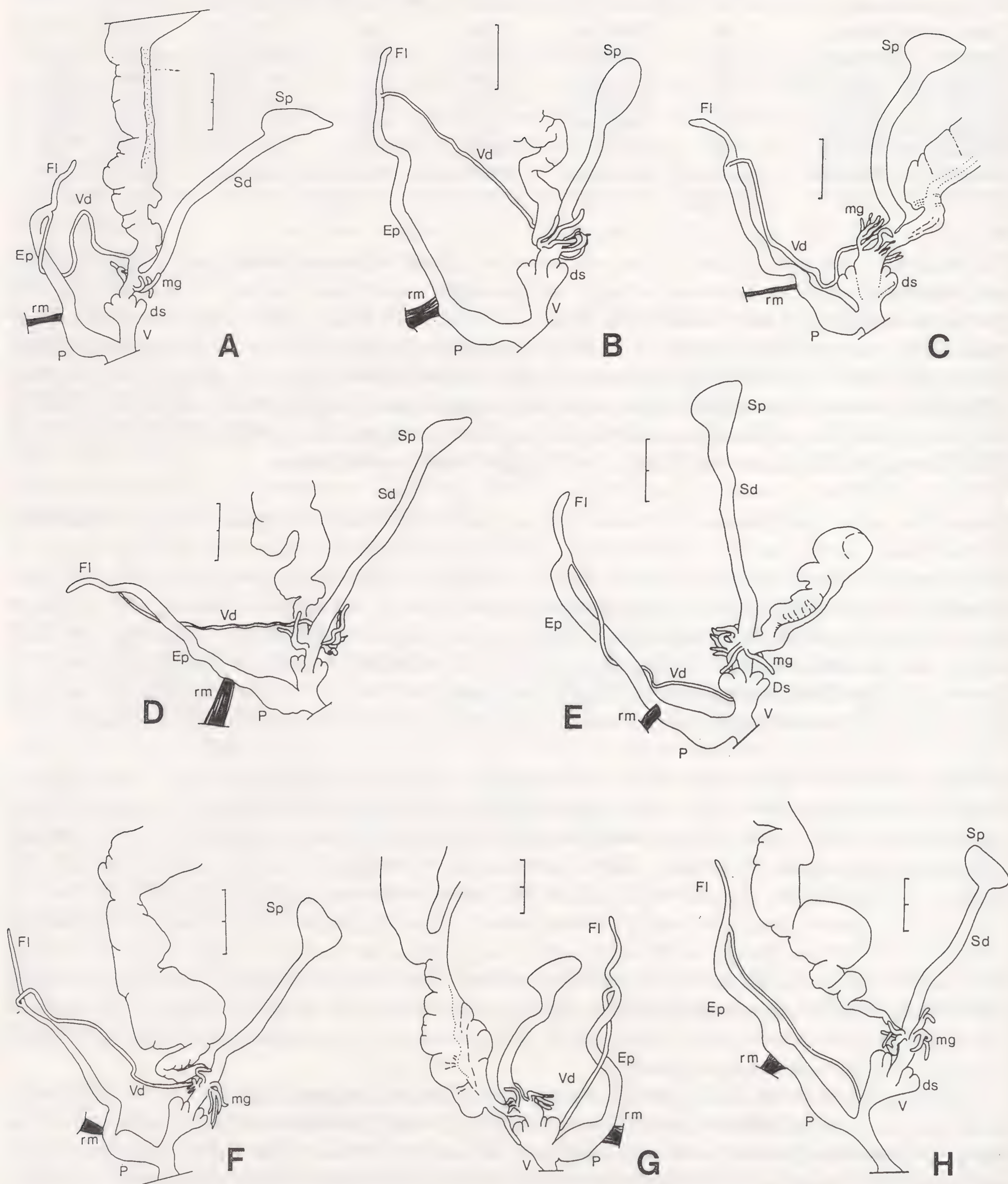
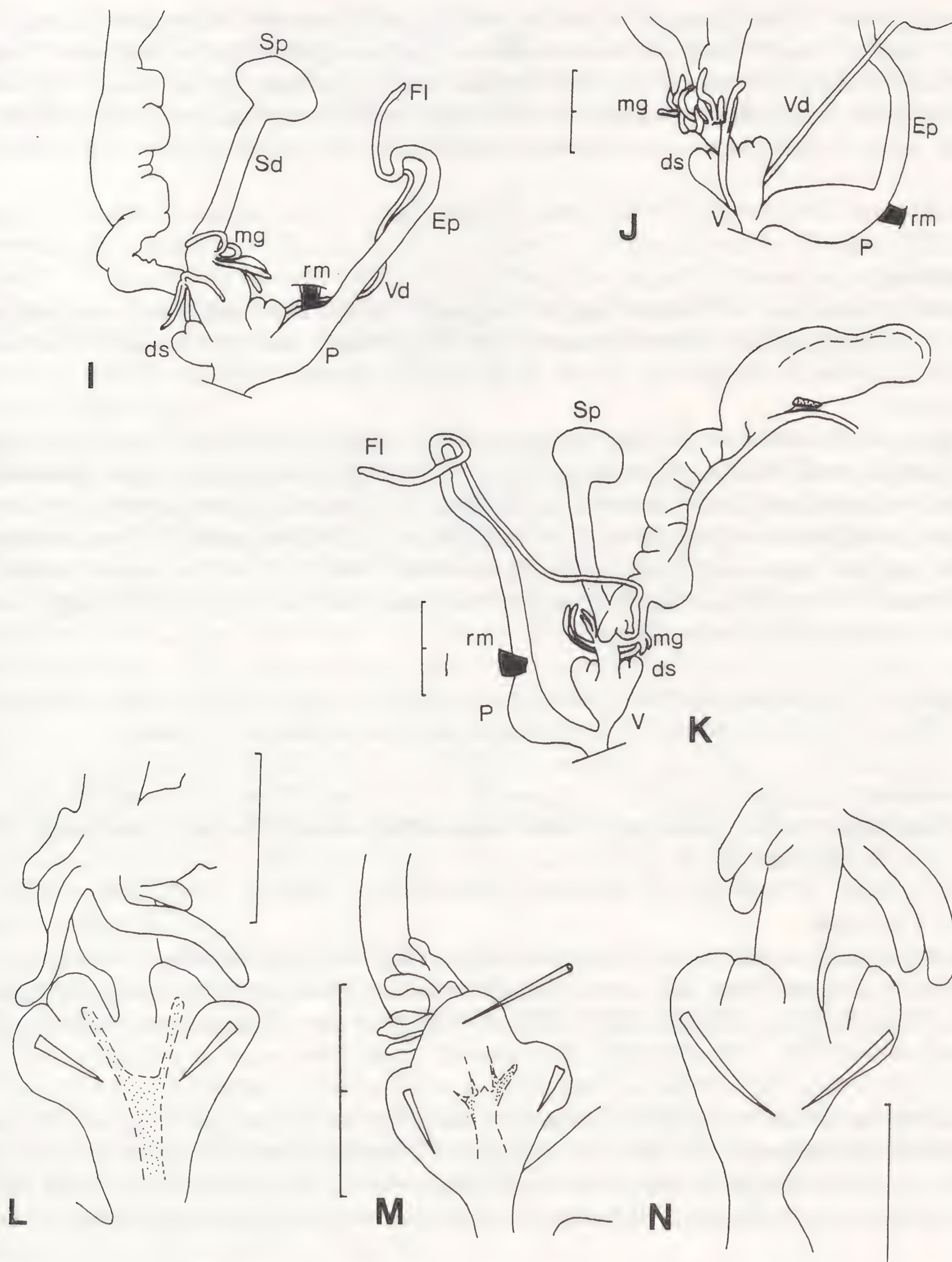


Fig. 2. Distal genitalia of animals dissected from Morocco; Material in Holyoak & Seddon Collections at NMWZ. Scale bar 2 mm. *Helicopsis (Xeroleuca) turcica* A. 1986.428 Fritissa; B.C.E.L.1986.159. Taftecht; D 1986.170 Tamanar; F. N. 1986.157 M'Zoudia; G.M 1986.167 Smimou; H 1986.415 Taoura; *Helicopsis (Xeroleuca) conopsis* I.J.K. 1986.277 N. of Safi.



Helicopsis (Xeroleuca) conopsis (Morelet, 1876)

Pl. 6b,d,f.

Helix conopsis Morelet, 1876 *J. Conchyl, Paris*, **24**, p. 375

Description:

Shell: The shell has 4.5–6 whorls. The shape is conical with a sharp keel; above the keel the body whorl is sometimes convex whereas immediately below the keel there is a slight concavity which accentuates the sharpness of the keel. The opaque, chalky shell is very pale grey to white; the shell structure gives a slightly roughened appearance to the underside. The upper side appears at first glance to be smooth. The first whorl has irregular, interrupted radial ribs. On the later whorls the growth ridges have small tubercles developed along them which give a slightly malleated appearance. On the underside of the

shell the sculpture is more prominent and is made up of elongated tubercles running from just under the keel to the edge of the umbilicus. The suture is slightly impressed and the tubercles at the edge of the keel give a slightly puckered appearance to the suture. On the last whorl the mouth starts to descend so that it is scalariform over about half a whorl. The columellar axis of the mouth also becomes slightly reflected.

Shell measurements: Diameter 10.9–12.5 mm; Height 8.1–8.9 mm.

Genital anatomy:

Male organs: the penis is 2.5–2.8 mm long with a papilla where the central and anterior part of the penis is enlarged. The retractor muscle of the penis is short and wide. The slender epiphallus (5–6 mm) is double the length of the penis and the flagellum (3–4 mm) is longer than the penis.

Female organs: there are four clearly distinguishable dart-sacs (1.7–2.2 mm); their size is proportionately small (shorter than the penis and about half the length of the spermathecal duct). The external dart-sacs contain a small dart. The vagina is conspicuous between the pairs of dart sacs; proximally it shows a free vaginal neck (1.5 mm) which is proportionately long. The vaginal mucous glands vary in number from 8 to 12 terminal tubes. The spermathecae is bean-like in shape. The spermathecal duct is long (4.0–4.5 mm), almost double the length of the spermathecae.

Range: *Helicopsis (Xeroleuca) conopsis* is only known from a small region on the west coast of Morocco (Fig. 1). The type locality for the species is Cap Cantin (= Safi).

Material examined:

Holotype and 2 paratypes, [Morelet] British Museum (Natural History), London (BMNH. 1893.2.4.393–95) Morocco.

X. conopsis Morelet, 1876 [Pallary], Melvill-Tomlin Colln., NMWZ. 1955.158 Cap Cantin; 1 specimen; Topotype.

Shell material from three sites was available in the Holyoak & Seddon Collection. Spirit material was examined from two sites; 3 specimens were dissected from a locality near Safi (32°33'N, 9°15'W) (Figs. 2.I.J.K. HS# 1986.277.17) and one specimen was dissected from Cap Bouddouza (HS# 1986.278.11).

Ecology: *Helicopsis (Xeroleuca) conopsis* is found in coastal regions. The specimens were living on flat limestone areas above the seacliffs, at about 30 m elevation. These areas have many rock-slabs scattered on the surface and a vegetation cover of scattered herbs and grasses. Living specimens were found aestivating on the tops, sides and underneath the scattered stones.

TAXONOMIC DISCUSSION

Helicopsis (Xeroleuca) turcica

Schepman (1876), Kobelt (1875), and Hesse (1934) have described the genital anatomy of three *Xeroleuca*; *X. mograbina*, *X. turcica* and *X. degenerans*. No information about differences between them was given. Hesse noted that all three species have very small darts. From Hesse's (1934) descriptions we noted that the genitalia of all three are very similar.

Thirty-four specimens were dissected from 17 localities in Morocco. (Holyoak & Seddon Collection, NMWZ). Despite the wide range in shell form there do not appear to be any

significant differences in the structure of the genitalia (Figs. 2 A–H) which show little variation between the specimens examined. Since all of the widely divergent shell forms replace each other geographically, none of them coexist at one site, and in some cases different shell forms are connected by shells with intermediate characters, we treat them all as members of a single species.

Helicopsis (Xeroleuca) conopsis

The specimens studied are similar to those figured and described by Pallary (1923, 1936) and match Pallary material in NMWZ collections. The animals dissected were collected in the region near to the type site at Cap Cantin. On the basis of the consistent differences in shell form and distal genitalia described below, we consider this to be a separate species.

Differences between species

Helicopsis (Xeroleuca) turcica and *Helicopsis (Xeroleuca) conopsis* differ in the following characters: *H. (X.) turcica* has a bigger, more solid shell, which has a more prominent shell sculpture. *H. (X.) conopsis* is less variable in shell characters with a conical shell, a sharp keel and white opaque shell with slight granular sculpture. The distal genitalia show consistent differences. *H. (X.) turcica* has a shorter flagellum (mean length 2.62 mm) and a longer spermathecal duct (mean length 6.03 mm) than *H. (X.) conopsis* (length of flagellum, mean 3.33 mm; length of spermathecal duct, mean 4.33 mm). The shape of the spermathecae is more rounded in *H. (X.) conopsis* than *H. (X.) turcica* which is also more variable in form. *H. (X.) conopsis* has dark pigmentation in the distal part of the spermathecal duct (and sometimes in the proximal part) and on the distal part of the ovospermiduct; this is lacking in *H. (X.) turcica*.

The range of the two species in Morocco does not overlap (Fig. 1). *Helicopsis (Xeroleuca) conopsis* is only found in a small area in NW. Morocco. It seems to be restricted to the coastal regions above sea-cliffs. *Helicopsis (Xeroleuca) turcica* occupies a wider range of habitats, although in some areas it also lives in the same habitats as *H. (X.) conopsis*.

Variability within species

The shape of the shells from different populations of *H. (X.) turcica* in Morocco vary considerably. The forms gradually change from site to site and hence it is difficult to confidently assign subspecific status at present. The specimens from some populations are also rather variable in shape (see range of sizes in Table 1).

The most extreme forms are those described as *Helix mograbina* (Morelet, 1852), *Xeroleuca brulardi* (Pallary, 1913) and *Xeroleuca babelis* (Pallary, 1920) from NE. Morocco and *Helix turcica* (Holten, 1802), *Helix mogadorensis* Bourguignat (1863), *X. depressiuscula* Pallary, 1936 from W. Morocco; animals from shells matching Pallary and Rolle material in the NMWZ collections were dissected. There was little consistent difference between any of the distal genitalia of the specimens (Fig. 2A–H).

The shell shape of *Helicopsis (Xeroleuca) turcica* may be related to the substrate on which the animals are found. Keel forms are often found in limestone (5/6 sites) or calcareous sandstone (9/15 sites) where there are angular crevices on rocky slopes available for the animals to aestivate in (Seddon, unpublished data). This trend is similar for many Mediterranean helicids (Goodfriend, 1986). There is no regional trend in the presence or absence of keeled forms; both are found in West and North-East Morocco.

Helicopsis (Xeroleuca) conopsis has a keeled shell; this species is found on limestone areas with plenty of flat rocks with crevices for aestivation.

Generic Relationships

We treat *Xeroleuca* as a subgenus of *Helicopsis* on the basis of the similarities in genital anatomy; namely the presence of four dart-sacs of similar sizes placed in pairs on either side

of the vagina. However, there are some consistent differences which are not found in *Helicopsis* (*sensu stricto*). The shell is medium-sized, solid and has distinct granular shell sculpture. The dart-sacs are proportionately smaller and contain small darts which do not fill the inner space of the sacs. All of the species of the subgenus *Xeroleuca* have a conspicuous free vaginal neck which is not found in *Helicopsis* (*sensu stricto*). Perhaps in the future when further characters are analysed the taxonomic status of *Xeroleuca* will be reconsidered.

Adaptation to environment

Species of the subgenus *Xeroleuca* in Morocco have white, chalky and solid shells. This is presumably an advantage if the species is aestivating in exposed sites. The white colouration enables a greater proportion of heat to be reflected and hence probably reduces the water-loss from the animal (Goodfriend, 1986).

OTHER SPECIES REFERRED TO *XEROLEUCA*

Helix argonautula Webb & Berthelot, 1833, *Ann. Sci. Nat.*, **28** (111), syn. 21, p. 325. syn. var. *canariensis*, var. *typica* Mousson, 1874; *renati* Dautzenberg, 1894. Range: W. Morocco (region of Casablanca, *fide* Wollaston 1878, Pallary 1936). Genital anatomy: described by Seddon, Aparicio and Holyoak in prep.; this species is found to belong to the genus *Helicella*.

Xeroleuca (*Disculus*) *mazancourtiana* Pallary, 1928 *J. Conchyl. Paris*, **72**, pp.1–24, pl.1–4. Type locality: Near Talzent, Gorges du Meskedal, Moyen Atlas. Syntypes and topotypes have been examined in the BM(NH) and NMWZ collections). As Pallary (1928) points out the shells are similar to in shape and shell sculpture to *Helicella argonautula* hence the generic classification should be verified by genital anatomy.

Xeroleuca (*Disculus*) *antoinei* Pallary, 1936 *J. Conchyl., Paris*, **80**, pp. 16–17, Range: Endemic in Morocco. On the basis of size and shape this species is likely to be related to *Helicella argonautula* although this has yet to be verified using characters such as genital anatomy.

Xeroleuca gouliminensis Pallary, 1936, *J. Conchyl., Paris*, **80**, pp. 14–15, pl. 3, fig. 1. Range: Endemic in W. Morocco (near Goulimine). Genital anatomy: Material studied by Seddon *et al.* (in prep.) indicate that this species belongs to the genus *Candidula*.

Helix cyclostremoides Sowerby, 1888, *Proc. zool. Soc. Lond.*, p. 212, pl. 11, fig. 14. Range: endemic in Morocco (type locality; “M’tul between Marrakesh and Mazagan, Morocco”). *Material examined*: Holotype, [Ponsonby] British Museum (Natural History), London. Melvill-Tomlin Colln. 1 juv specimen, (NMWZ. 1955.158) labelled Marrakesh. Shell form is suggestive of *Xeroleuca*, although the shells are smaller; verification through study of the genital anatomy is required.

SIGNIFICANCE OF THE DART-SAC COMPLEX IN *HELICOPSIS* (*XEROLEUCA*)

Helicopsis differs from other genera of the traditional Helicellinae primarily in the structure of the dart-sac complex. This has two pairs of conspicuous sacs placed on either side of the vagina, the inner one is empty and the outer sac contains a dart (Hesse, 1934). Recent work by Hausdorf (1988) and Giusti and Manganelli (1989, 1990) has showed that some of the other Helicellinae have inconspicuous inner dart sacs which are only distinguishable when the dart-sac complex is dissected carefully. Hence, it is possible that *Helicopsis* may be less sharply demarcated from other genera than the early definitive studies by Hesse (1934) indicated.

The function of the inner dart-sac is uncertain. It does not contain a dart in any of the Helicacea. It may contain glandular tissue since the interior opens downwards towards the vagina (Fig. 2 L–M). Histological studies are needed to investigate this possibility.

Evolution of the dart-sac complex in the Helicellinae poses a number of problems. The inner sac could have originated in several ways: (a) through reduction of the dart-bearing sac, (b) through partial duplication of the dart-sac during development or (c) through progressive enlargement of the glandular tissues associated with the dart-sac. Given these various possibilities it is difficult to decide at present whether the structure of the dart-sac complex in *Helicopsis* represents an advanced stage of its evolution or a primitive stage, especially as there is no strong evidence as to which of the other Helicellinae genera are most closely related to *Helicopsis*.

At present some authors use genital characters to deduce phylogeny whereas others are using the phylogenetic relationships to interpret the evolution of the genitalia. We must therefore look to using other characters to help clarify phylogenetic relationships in order to avoid circular argument. Until these relationships are better understood the classification of Helicellinae will inevitably remain provisional.

ACKNOWLEDGEMENTS

Thanks are due to Cheltenham and Gloucester College of Higher Education (formerly the College of St Paul and St. Mary) for support of the project from 1986–1989. Mr. Marcel Holyoak provided cheerful assistance in the field. The Nuffield Foundation provided a research microscope for the project. M.-T. Aparicio was given a grant from Ministerio de Educacion y Ciencia allowing her participation in this paper. MBS completed this study at the NMW with support from the Leverhulme Trust. We wish to thank Dr. P. G. Oliver and an unknown referee for their comments on the manuscript; the staffs at the BM(NH), NMW and University Museum of Zoology, Cambridge for access to specimens in their care and to Mr. Kevin Thomas for the photography.

REFERENCES

- APARICIO, M.-T. & RAMOS, M. A., 1987. New observations on *Helicella stiparum* Rossmässler, 1854 (Gastropoda, Pulmonata, Helicidae). *J. Conch., Lond.*, **32**: 355–363.
- GIUSTI, F. & MANGANELLI, G., 1987. On some Hygromidae (Gastropoda: Helicoidea) living in Sardinia and Corsica. *Boll. Malacologica*, **23**: 123–206.
- , 1989. Notulae Malacologia XLIV. A new hygromid from the Tyrrhenian islands of Capraia and Sardinia and notes on the genera *Xeromica* and *Xerotrichia* (Pulmonata: Helicoidea). *Boll. Malacologica*, **5**: 23–62.
- , 1990. *Ciliellopsis oglasae*, a new hygromid from Montecristo Island (Tuscan Archipelago, Italy) (Pulmonata: Helicoidea) *J. Conch., Lond.*, **33**: 269–277.
- GOODFRIEND, G. A., 1986. Variation in Land-snail shell form and size and its causes: a review. *Syst. Zool.* **35**: 204–223.
- HAUSDORF, B., 1990 (for 1989). Zur kenntnis der systemstiscen Beziehungen einiger Taxa der Helicellinae Ihering 1909. *Arch. Molluskenk.* **119**: 9–37.
- HESSE, P., 1934. Zur anatomie und systematik palaerktischer Stylommatophoran II Tiel. *Zoologica*, **33**: 1–59.
- KERNEY, M. P. & CAMERON, R. A. D., 1979. *A Field Guide to the Land Snails of Britain and north-west Europe*. Collins, London.
- KOBELT, W., 1875. Die gattung *Leucochroa*. *Nachr.-Bl. Deutsch. malac. Ges.*, **7**: 37–40.
- MANGANELLI, G. & GIUSTI, F., 1987. A new hygrominiidae from the Italian Apennines and notes on the genus *Cernuella* and related taxa (Pulmonata: Helicoidea). *Boll. Malacologica*, **23**: 327–380.
- , 1989. *Xeromunde* Di Maria di Monterosato in Italy (Pulmonata: Hygromiidae). *Boll. Malacologica*, **25**: 1–22.
- MORELET, A., 1876. Description de trois Helices du Maroc. *J. Conchyl., Paris*, **24**: 374–376.

- NORDSIECK, H., 1986. The system of the Stylommatophora (Gastropoda) with special regard to the systematic position of the Clausiilidae. II Importance of shell and distribution. *Arch. Molluskenk.*, **117**: 93–116.
- , 1987. Revision des systems der Helicoidea (Gastropoda: Stylommatophora) *Arch. Molluskenk.*, **118**: 9–50.
- PALLARY, P., 1920. Description d'une nouvelle cinquantaine de Mollusques terrestres nouveaux. *Bull. Soc. Hist. nat. Afr. N.*, **11**: 18–34.
- , 1923. Vingt Mollusques terrestres nouveaux du Maroc. *Bull. Soc. Hist. nat. Afr. N.*, **4**: 112–118.
- , 1928. Notice sur seize mollusques nouveaux du Maroc decouverts en 1926 et 1927. *J. Conchyl., Paris*, **72**: 1–24, pl. 1–4.
- , 1936. Deuxième complement a la Faune a la Faune malacologique de la Berberie. *J. Conchyl., Paris.*, **80**: 5–65 (pl. 1–4)
- SCHEPPMAN, 1876. *Helix mograbina* Mor. und *Helix degenerens* Mouss. *Nachr.-Bla. Deutsch. mal. Ges.*, **8**: 135.
- SCHILEYKO, A. A., 1973. Comparative characteristics of the Palaearctic families of terrestrial molluscs from the superfamily Helicoidea. *Zool. J.*, **52**: 492–506.
- , 1978. *Molluscs; Land Mollusca of the superfamily Helicoidea Fauna SSSR (N.S.)*, **17**: 1–363. [in Russian].

ON THE DISTRIBUTION OF THE NORTHWEST EUROPEAN SPECIES OF THE GASTROPOD *HYDROBIA*, WITH PARTICULAR REFERENCE TO *H. NEGLECTA*

R. S. K. BARNES¹

(Accepted for publication, 22nd April, 1991)

Abstract: The distribution, habitat preferences and coexistence of *Hydrobia ulvae*, *H. ventrosa* and *H. neglecta* are briefly reviewed, especially in the light of a new record of *H. neglecta* that is the first from France (and from continental Europe outside of Denmark) and the first of this species from a fully marine intertidal zone.

Three species of the rissoacean genus *Hydrobia* Hartmann are known to occur in coastal regions of northwestern Europe: *H. (Peringia) ulvae* (Pennant), *H. (Hydrobia) ventrosa* (Montagu) and *H. (Hydrobia) neglecta* Muus. Of these, *H. ulvae* is by far the commonest species, occurring in large numbers – up to 300,000/m² (Linke 1939, Smidt 1951) – in the intertidal zones of most estuaries and sheltered marine embayments. In the northern Wadden Sea, for example, it comprises more than 75% of the average ash-free macrofaunal biomass and it accounts for at least 67% (and up to 90%) of the energy flow through the soft-sediment macrofauna (Asmus & Asmus 1985). It also occurs subtidally (e.g. Dekker 1989) and in landlocked coastal lagoons (Barnes 1987), although in non-tidal coastal localities it is usually replaced by *H. ventrosa* and/or *H. neglecta*. Its recorded range extends along most of northeastern Atlantic seaboard, from north Norway and Arctic Russia to west Africa, including parts of the Baltic (Zenkevitch 1963, Graham 1988); records from the Mediterranean, however, remain to be substantiated.

The distributions of *H. ventrosa* and *H. neglecta* are less well known, principally because the latter species was not differentiated from the former until 1963 (Muus 1963) but also because of possible confusion between *H. ventrosa* and '*H. stagnorum*' (Gmelin) (Bank *et al.* 1979), now termed *Semisalsa stagnorum* and regarded as being of uncertain position within the Rissoacea (Bank & Butot 1984). *S. stagnorum* has been found in the living state as yet only from The Netherlands but is known from fossil or subfossil material from the English Channel (Bank & Butot 1984, Meijer 1990). The range of *H. ventrosa*, however, does appear to be wide and to be equivalent to that of *H. ulvae* (Graham 1988) except that it is definitely known from the Mediterranean (e.g. Cesari 1988) and it, or a closely similar species, occurs in the Ponto-Caspian seas, including even the Aral (Zenkevitch 1963, Remane 1971). Most northwest European records are from non-tidal lagoons or lagoon-like habitats, although intertidal marine or brackish-water populations are known, for instance in Breydon Water, Suffolk (Cherrill & James 1985). Its occurrence through the Atlantic region, reflecting that of its preferred habitat, is much more sporadic than that of *H. ulvae*.

The recorded distribution of *H. neglecta* is even more patchy, but although sporadic, where either species does occur it may achieve high density, commonly 30,000/m² (Siegismund 1982). *H. neglecta* is currently known only from the Limfjord and Kattegat in

¹ Department of Zoology, University of Cambridge, Cambridge CB2 3EJ, U.K.

Denmark and from a handful of scattered sites around the North Sea coast of England, the western coasts of Scotland and Ireland, and in Guernsey (Bishop 1976, Hylleberg 1986, Graham 1988). All previous records have been from lagoonal habitats. In 1989, however, the author discovered a population of *H. neglecta* in the Anse Lostrouc'h, near the mouth of the Aber Vrac'h, Finistère, France, living just below the high water neap tide level in the intertidal marine habitat (Fig. 1). These snails possessed elongate, tightly spiral shells of up to seven whorls, with shell height some 2.8 times maximum shell width; most specimens had a dark, completely pigmented head, and the tentacles were completely dark (except for a longitudinal pigmentless line) in about one third of individuals; penis morphology, however, was normal. In mid August 1989, the population was bimodal, the mean shell heights of the two cohorts being 1.3 and 3.1 mm (based on 463 specimens). This record of *H. neglecta* from Finistère is then the first one from France and therefore the first record of it from continental Europe outside Denmark; it is the first record of the species from a fully marine, macrotidal littoral zone; and it also establishes the most southerly known population of what appears on the basis of its response to climatic factors (Muus 1967) to be an essentially northern species, being for example relatively intolerant of high temperatures (Lassen & Kristensen 1978, Hylleberg & Siegismund 1987). The French population is sympatric with *H. ulvae*, which in mid August 1989 were unimodal with a mean shell height of 5.2 mm. A further visit in August 1990 confirmed this situation.

Sympatry between *Hydrobia* species has frequently been reported. Of the nearly 240 localities in the Limfjord and Kattegat, Denmark, surveyed by Fenchel (1975) and Hylleberg (1986), for example, *H. neglecta* and *H. ventrosa* occurred together in 26% of sites, *H. ulvae* and *H. ventrosa* were both found in 16%, all three species were recorded from 14%, and

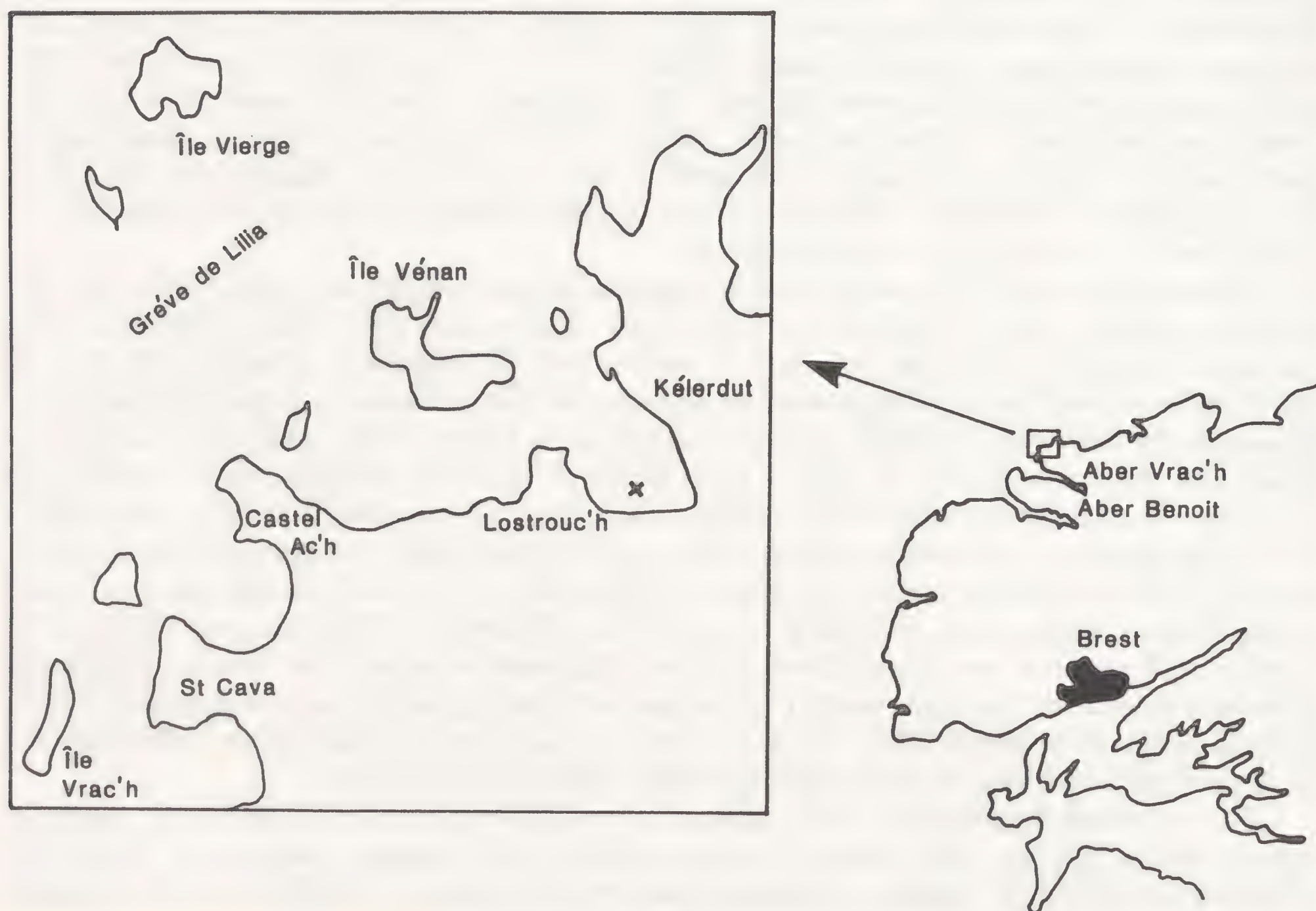


Fig. 1. The location (marked by an x) of the recently discovered intertidal marine population of *Hydrobia neglecta* in the extreme west of France.

H. ulvae and *H. neglecta* coexisted in 5%. In East Anglia, U.K., out of 70 sites supporting *Hydrobia*, the equivalent figures were: *ventrosa* + *ulvae* 8%; *ventrosa* + *neglecta* 6%; all three 1%; *ulvae* + *neglecta* 0% (Cherrill & James 1985). *H. ulvae* plus *H. neglecta* is in both cases the rarest combination. Although this can be interpreted as an effect of competitive interactions (e.g. Fenchel & Kofoed 1976), in large measure it can be explained by the rarity of *H. neglecta* – *H. neglecta* formed single species populations in only 1% of the East Anglian *Hydrobia* sites and in only 3% of the Danish ones – and by the fact that *H. neglecta* only very rarely occurs at all in the habitat type that appears to be the main one of *H. ulvae*. The extent to which the various species are really co-existing in several of the shared sites is also questionable. At the Aber Vrac'h locality, *H. neglecta* occurs only in and around a bed of *Zostera nana* growing in coarse sand from which *H. ulvae* is to all intents and purposes absent, whilst *H. ulvae* is present on the surrounding unvegetated sandflats. Only in a narrow transitional zone between the *Zostera* and the bare sandflat are both species present. Similarly, in the East Anglian sites surveyed by Barnes (1987, 1989a), although *H. ventrosa* and *H. neglecta* occurred 'together' in both the Dunwich and Shingle Street lagoon systems, an individual small lagoon containing one of the species did not support the other. Thus in those localities with which the author is familiar, sympatry does not often extend to mixed populations; in others 'coexistence' appears to be a consequence of continual dispersal of more than one species into the same area (Siegismund & Hylleberg 1987).

In Denmark, spatial separation of the three species is also evident on a broad geographical scale. Muus (1963) first reported an apparent relationship between their distributions and salinity, with *H. ulvae* being found in the high salinity areas, *H. ventrosa* in the lowest salinities, and the range of *H. neglecta* being sandwiched between the other two. Such a relationship does not seem to apply elsewhere, however. In British lagoons, for example, all three frequently have (separately) been recorded from sites with a salinity in excess of 35‰, and the ranges of *H. ventrosa* and *H. ulvae* are the same to within 4‰ (*ulvae* 5–40‰; *ventrosa* 1–36‰) (Barnes 1987, 1989b, Graham 1988). In the Kattegat, the salinity gradient is paralleled by ones of increasing shelter and tidelessness, so that the observation that *H. ulvae* occurs in the outer Kattegat, *H. neglecta* in its central region, and *H. ventrosa* in the inner Kattegat (Hylleberg 1986) can also be a reflection of the broad habitat preferences of the three species along an intertidal-marine to nontidal-lagoonal gradient, irrespective of salinity.

There is no problem accounting for the dispersal of *H. ulvae* in that it has planktonic larvae and its preferred soft-sediment coastal habitat is widely distributed around the shores of western Europe. Being largely confined to more or less landlocked lagoons and hatching directly as young benthic snails, how *H. ventrosa* and *H. neglecta* colonize new localities is much more problematic. Barnes (1988) concluded that they were most likely to be dispersed via floating mats of filamentous algae and dislodged macrophytes such as *Ruppia* at times of storm-surge induced coastal flooding. Granted that sea defences have now rendered incursions of sea water less likely around most of Atlantic Europe, many populations of these two species are now effectively isolated and relict. Indeed, although it is certain that further populations of *H. neglecta* remain to be discovered, its sporadic distribution may well result from the consequent imbalance between colonization abilities and extinction. The Aber Vrac'h marine population may have been originated by individuals washed out of a former lagoon, equivalently to the *Cerastoderma glaucum* (Bruguière) population in Southampton Water (Barnes 1973). The brackish lagoonal habitat was once widespread in Brittany (Poncet *et al.* 1979, Jéquel & Rouve 1983) although much of it is now reclaimed or has evolved into freshwater lakes (Barnes 1991). This natural and anthropogenic habitat destruction is probably a further potent cause of the patchy distributions of many lagoonal species.

REFERENCES

- ASMUS, H. & ASMUS, R., 1985. The importance of grazing food chain for energy flow and production in three intertidal sand bottom communities of the northern Wadden Sea. *Helgol. Meeres.*, **39**: 273–301.
- BANK, R. A. & BUTOT, L. J. M., 1984. Some more data on *Hydrobia ventrosa* (Montagu, 1803) and “*Hydrobia*” *stagnorum* (Gmelin, 1781) with remarks on the genus *Semisalsa* Radoman, 1974. *Malakol. Abh.*, **10**: 5–15.
- BANK, R. A., BUTOT, L. J. M. & GITTENBERGER, E., 1979. On the identity of *Helix stagnorum* Gmelin, 1791, and *Turbo ventrosus* Montagu, 1803 (Prosobranchia, Hydrobiidae). *Basteria*, **43**: 51–60.
- BARNES, R. S. K., 1973. The intertidal lamellibranchs of Southampton Water, with particular reference to *Cerastoderma edule* and *C. glaucum*. *Proc. malac. Soc. Lond.*, **40**: 413–433.
- , 1987. Coastal lagoons of East Anglia, U.K. *J. coast. Res.*, **3**: 417–427.
- , 1988. The faunas of land-locked lagoons: chance differences and the problems of dispersal. *Est. coast. shelf Sci.*, **26**: 309–318.
- , 1989a. The coastal lagoons of Britain: An overview and conservation appraisal. *Biol. Conserv.*, **49**: 295–313.
- , 1989b. What, if anything, is a brackish-water fauna? *Trans. Roy. Soc. Edinb., Earth Sci.*, **80**: 235–240.
- , 1991. Dilemmas in the theory and practice of biological conservation as exemplified by British coastal lagoons. *Biol. Conserv.*, **55**: 315–328.
- BISHOP, M. J., 1976. *Hydrobia neglecta* Muus in the British Isles. *J. moll. Stud.*, **42**: 319–326.
- CESARI, P., 1988. La malacofauna della Laguna Veneta – 1. I Gasteropodi terrestri, dulciacquicoli e salmastri dei litorali di Pellestrina, Lido e Cavallino. *Boll. Mus. Civ. Stor. Nat. Venezia*, **38**: 7–42.
- CHERRILL, A. J. & JAMES, R., 1985. The distribution and habitat preferences of four species of Hydrobiidae in East Anglia. *J. Conch., Lond.*, **32**: 123–133.
- DEKKER, R., 1989. The macrozoobenthos of the subtidal western Dutch Wadden Sea. 1. Biomass and species richness. *Neth. J. Sea Res.*, **23**: 57–68.
- FENCHEL, T., 1975. Factors determining the distribution patterns of mud snails (Hydrobiidae). *Oecologia (Berl.)*, **20**: 1–17.
- FENCHEL, T. & KOFOED, L. H., 1976. Evidence for exploitative interspecific competition in mud snails (Hydrobiidae). *Oikos*, **27**: 367–376.
- GRAHAM, A., 1988. *Molluscs: Prosobranch and Pyramidellid Gastropods. (Synopsis Brit. Fauna (New Ser.), No. 2, 2nd Edn)*. Brill/Backhuys, Leiden.
- HYLLEBERG, J., 1986. Distribution of hydrobiid snails in relation to salinity, with emphasis on shell size and co-existence of the species. *Ophelia*, Suppl. 4: 85–100.
- HYLLEBERG, J. & SIEGISMUND, H. R., 1987. Niche overlap in mud snails (Hydrobiidae): freezing tolerance. *Mar. Biol. (Berl.)*, **94**: 403–407.
- JÉQUEL, N. & ROUVE, D., 1983. *Marais Vasières Estuaires*. Ouest France, Rennes.
- LASSEN, H. H. & KRISTENSEN, J. H., 1978. Tolerance to abiotic factors in mudsnails (Hydrobiidae). *Nat. Jutl.*, **20**: 243–250.
- LINKE, O., 1939. Die Biota des Jadebusenwattes. *Helgol. wiss. Meeres.*, **3**: 201–348.
- MEIJER, T., 1990. Notes on Quaternary freshwater Mollusca of the Netherlands, with descriptions of some new species. *Meded. Wenkgr. Tert. Kwart. Geol.*, **26**: 145–181.
- MUUS, B. J., 1963. Some Danish Hydrobiidae with the description of a new species, *Hydrobia neglecta*. *Proc. malac. Soc. Lond.*, **35**: 131–138.
- , 1967. The fauna of Danish estuaries and lagoons. , *Meddr Danm. Fisk.-og Havunders. (Ny Ser.)*, **5**: 1–316.
- PONCET, F., HALLEGOUET, B. & LE DMEZET, M., 1979. Les zones humides littorales de Bretagne et leur évolution. *Penn ar Bed*, **12**: 177–191.
- REMANE, A., 1971. Ecology of brackish water. *Die Binnengewässer*, **25**, 1–210.
- SIEGISMUND, H. R. & HYLLEBERG, J., 1987. Dispersal-mediated coexistence of mud snails (Hydrobiidae) in an estuary. *Mar. Biol. (Berl.)*, **94**: 395–402.
- SMIDT, E. L. B., 1951. Animal production in the Danish Waddensea. *Meddr Kommn Danm. Fisk.-og Havunders. (Ser. Fisk.)*, **11**: 1–151.
- ZENKEVITCH, L., 1963. *Biology of the Seas of the U.S.S.R.* Allen & Unwin, London.

MODERN LAND MOLLUSC COMMUNITIES FROM FLAT HOLM, SOUTH GLAMORGAN

M. S. YOUNG AND J. G. EVANS¹

(Accepted for publication, 22nd April, 1991)

Abstract: Modern land molluscan communities on the island of Flat Holm in the Bristol Channel are described. Most are from grassland which has been disturbed by breeding gulls and human activity. There are three main molluscan species which favour unstable habitats, and eighteen others, and cluster analysis suggests the existence of five groups or communities. For the main areas of grassland, there appears to be little correlation between the communities and habitat factors. It is suggested that the different communities reflect the generally unstable nature of the island's environment. Comparison with grasslands further east in Britain shows a paucity on Flat Holm of the more traditional xerophiles, and the significance of this in the use of subfossil assemblages for environmental reconstruction is indicated.

INTRODUCTION

Quantitative data on modern grassland molluscan faunas are few, studies such as Chappell *et al.* (1971) and Cameron & Morgan-Huws (1975) being rare. This is unfortunate because the information would be useful in a range of ways from the intrinsic value of the data, to the information on habitat factors to which the molluscan faunas relate, their value as indicators of the degree of stress an ecosystem is suffering, and their use in archaeological interpretation. The investigation described here is part of a wider study on the grassland faunas of south Wales, initiated to aid in the interpretation of archaeological grassland assemblages, in particular from areas of milder climate than those of the south and east of England where the faunas are better known. More immediately, the study of the land mollusc fauna of Flat Holm originated as a part of a survey of the biology of the island in 1987 prior to a change of management. In the late 1950s the ecology of the island began to change because of an influx of breeding lesser black-backed and herring gulls (Salmon 1957, Vernon 1959). By 1974 they had reached a maximum of 8000 pairs and had virtually destroyed the former maritime grassland (Gillham 1984). One aim of the South Glamorgan County Council management policy was to restore this environment, so the mollusc survey was done as a baseline for future work.

FLAT HOLM

Flat Holm is an island in the Bristol Channel, 4 km from the Welsh mainland (NGR: ST 220649). It is almost circular, about 500 m across and of 23 ha, rising from around 5 m above MHW on the exposed western side to 30 m in the east. There is no surface freshwater. The geology is Carboniferous Limestone. The soil, however, is poorly calcareous perhaps because it is derived from previously overlying Triassic marls (Harrison & Wade 1976), and for this reason, subfossil shells are not preserved.

The climate is similar to that of the east Glamorgan seaboard. Mean temperatures are 11.9 to 19.3 °C for July and 1.3 to 6.6 °C for January, with the growing season, when

¹ School of History and Archaeology, University of Wales College of Cardiff, P.O. Box 909, Cardiff CF1 3XU

temperatures average more than 6 °C and there is no frost, extending from March to November. Rainfall is low, at around 90 cm, comparable to parts of south-east England, but the number of rain days is relatively uniformly spread through the year. Special features of Flat Holm climate are notably clear atmosphere, high insolation and sea mists. The Bristol Channel acts as a funnel, with gales possible at all times of the year. The western aspect of the island ensures maximum exposure to wind and salt spray, although the salinity of the Bristol Channel at this point is only 80% of normal seawater. Nevertheless, the cliff vegetation has halophytic species such as thrift, sea campion, sea beet and rock sea lavender in a turf of red fescue.

Flat Holm was farmed, conventionally and for rabbits, from the Middle Ages up to 1941. In addition to the farmhouse (now a study centre), many installations, including lighthouse, barracks and batteries, isolation hospital, and a bank and ditch complex, attest to the strategic importance of the island and to considerable disturbance by man. It was designated a local nature reserve by South Glamorgan County Council in 1975 (Warrall & Surtees 1984).

With the abandonment of farming and the growth of the gull colony, maritime grassland that once covered much of the island has been overgrown, by bramble and tall herbaceous vegetation dominated by nettles (*Urtica dioica*) and bracken (*Pteridium aquilinum*); *Dipsacus fullonum*, *Arcticum minus* and *Cynoglossum officinale* are common, and there are periodic epidemics of *Senecio jacobea* and *Cirsium arvense*. Elder (*Sambucus nigra*) has also spread rapidly since the 1970s. The remaining grassy areas are dominated by *Arrhenatherum elatius*. The effect of the gulls is various – uprooting, trampling and denudation. Eutrophication by guano (chiefly of phosphates and nitrates) kills some plants but is beneficial to others, especially nettles, dock (*Rumex acetosa*), Yorkshire fog (*Holcus lanatus*) and elder. Rabbits do little to control the vegetation (Gillham 1963, 1984).

In sum, the vegetation is species poor, with areas of tall herbs, scrub and bracken, disturbed ground and practically no mature grass sward. The soils are eutrophic and the potential benefits of the limestone geology unavailable to molluscs.

SAMPLES

The main areas sampled were grassland since this was the main habitat to be changed by management and where future changes in molluscan faunas are likely (Fig. 1). Specific locations were selected to include environments with differing vegetational diversity and height, and differing exposure. To obtain a broader picture, three other habitats were sampled: an area transitional from grassland to scrub, an area of bare earth and litter under elder and an area of rock rubble.

Twenty-six samples were taken (Table 3; Fig. 1) between October 1984 and October 1986. Each consisted of a turf or area of soil, 25 × 25 cm square and 5 cm deep, although the litter samples (25 and 26) and the rock-rubble sample (5) were from a wider, less precisely defined, area. All shells were extracted and a note made of the preservation, live, recently-dead, dead and subfossil, but since there were no apparent differences in the counts of the various categories they have been amalgamated. We note only that two species, *Helicella itala* and *Pupilla muscorum*, were represented by subfossil shells alone. The nomenclature is that of Kerney (1976).

Vegetation at each sample spot was recorded using the Domin scale of cover in a one-metre square (Hope-Simpson 1940) (Table 1). Height, as a measure of general height of vegetation, not the tallest individual, was also recorded (Table 2). The nomenclature is that of Clapham *et al.* (1958), and for grasses, Hubbard (1954).

In terms of habitat, the samples can be grouped as follows (Tables 1 and 2):

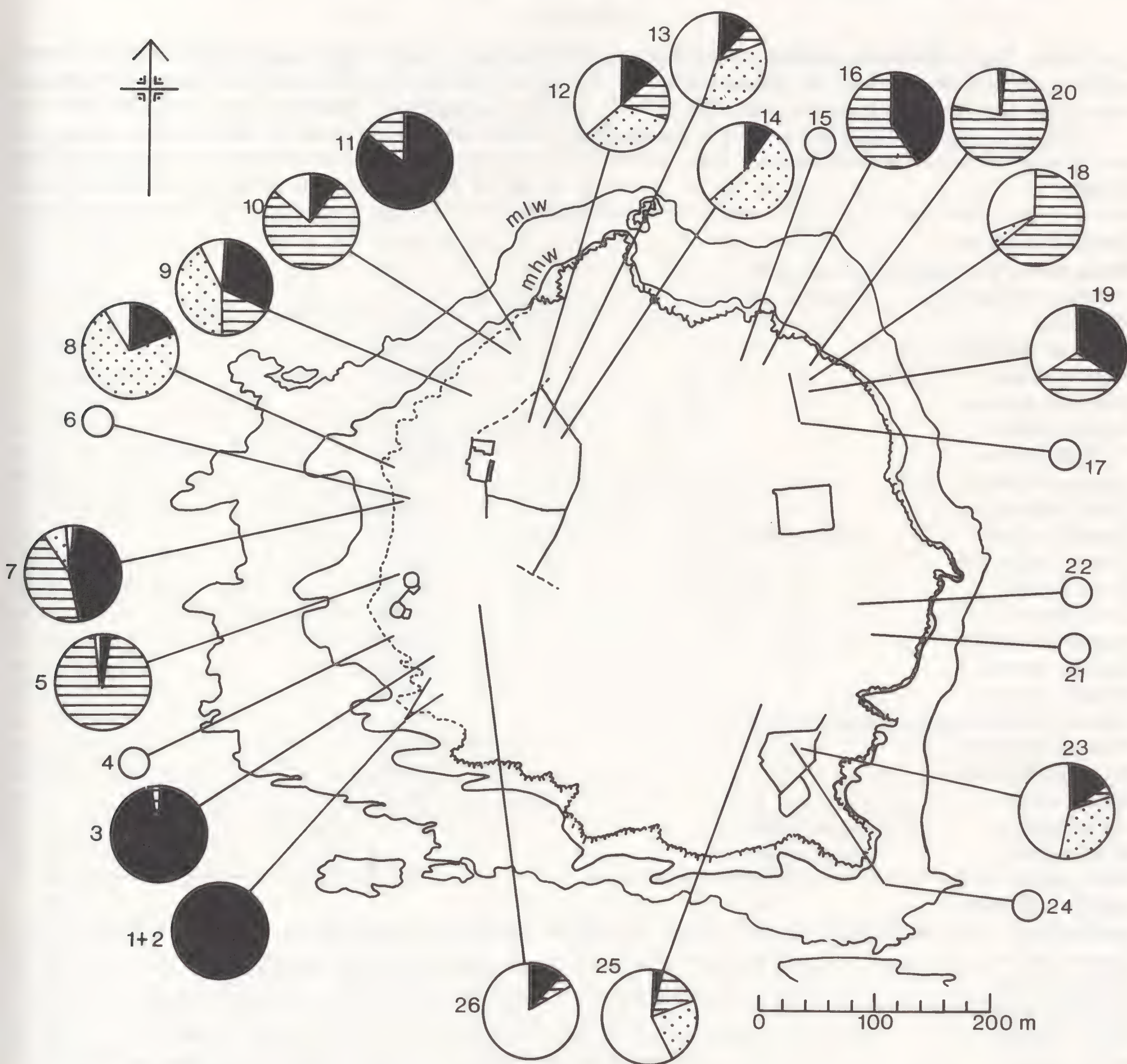


Fig. 1. Map of Flat Holm showing sampling locations and molluscan composition in terms of the three main species. Horizontal lines = *Lauria cylindracea*; black = *Oxychilus alliarius*; stipple = *Vallonia costata*; open = other species. Small circles are samples with shell numbers too low to plot.

Scree/Rock-rubble; sample 5.

Elder scrub, with litter and bare soil; samples 25 and 26.

Transitional from grassland to scrub, with tall herbs, with a more complex structure than grassland; samples 12, 13 and 14.

Grassland dominated by *Arrhenatherum elatius*; samples 1, 2, 3, 6, 7, 8, 9, 10, 11, 15, 16, 17, 18, 19, 20, 22, 23 and 24.

Short grassland, no *Arrhenatherum elatius*; samples 4 and 21.

RESULTS

The results (Table 3; Figs 1 and 2) are considered in three stages.

(1) The main characteristics of the fauna. The three main species, *Lauria cylindracea*, *Vallonia costata* and *Oxychilus alliarius*, and 'other species' are plotted as sector charts of percentage

TABLE 1

Flat Holm. Vegetation from molluscan sampling spots, 1–26, measured by cover using the Domin scale. Domin scale: 1, up to 2 individuals, no measurable cover; 2, several individuals, no measurable cover; 3, numerous individuals, less than 4% of area; 4, cover of 4–10%; 5, 11–25%; 6, 26–33%; 7, 34–50%; 8, 51–75%; 9, 76–90%; 10, 91–100%. (There are no entries for samples 5, rock rubble, and 25 and 26, elder scrub.)

Sample	1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<i>Pteridium aquilinum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–
<i>Ranunculus acris</i>	–	–	–	–	2	–	4	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	2
<i>Cochlearia officinalis</i>	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Viola hirta</i>	–	–	–	–	–	–	–	–	1	–	–	3	–	–	–	–	–	–	–	–	–	–	–
<i>Hypericum perforatum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	4
<i>Silene maritima</i>	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Cerastium fontanum</i>	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–
<i>Trifolium repens</i>	–	–	–	2	3	–	4	4	–	–	–	–	–	–	–	–	–	–	–	–	–	5	4
<i>Trifolium pratense</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	2	–	–	–	–
<i>Lotus corniculatus</i>	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	3	–	–	4	4
<i>Rubus fruticosus</i>	–	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	4	7
<i>Potentilla reptans</i>	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Poterium sanguisorba</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	5	–	–	–	–
<i>Rumex acetosa</i>	2	2	2	3	–	–	2	–	3	2	–	–	–	–	–	–	2	–	2	5	4	2	2
<i>Urtica dioica</i>	–	–	–	–	–	–	4	–	4	2	7	6	5	6	6	3	–	–	–	–	–	–	–
<i>Anagallis arvensis</i>	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Myosotis arvensis</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
<i>Prunella vulgaris</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	3
<i>Teucrium scorodonia</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	3
<i>Plantago lanceolata</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
<i>Glechoma hederacea</i>	–	–	–	–	–	–	–	–	1	–	–	–	–	–	4	–	–	–	–	–	–	5	5
<i>Galium verum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	5	2	4	–	–	–	–
<i>Galium aparine</i>	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
<i>Senecio jacobea</i>	–	–	–	–	4	2	4	–	–	2	–	1	2	2	–	–	–	2	–	–	–	2	2
<i>Bellis perennis</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	3	3
<i>Achillea millefolium</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–
<i>Arctium minus</i>	–	–	–	–	–	–	3	–	3	3	–	–	–	1	–	–	–	–	–	–	–	–	–
<i>Cirsium vulgare</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
<i>Cirsium arvense</i>	–	–	–	–	–	–	–	–	–	1	2	–	4	–	–	–	–	–	–	–	–	–	4
<i>Hieracium pilosella</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	4	–	–	–	–
<i>Crepis capillaris</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–
<i>Festuca rubra</i>	–	2	–	8	6	–	4	4	5	5	3	4	3	6	4	8	6	–	6	8	3	6	7
<i>Poa pratensis</i>	–	–	–	–	3	–	–	–	–	–	6	7	–	5	5	–	–	–	–	8	–	–	–
<i>Dactylis glomerata</i>	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	4	–	–	–	–	–
<i>Arrhenatherum elatius</i>	9	10	10	–	8	10	9	9	8	8	5	–	–	7	8	8	9	10	8	–	9	7	8
<i>Holcus lanatus</i>	4	2	3	5	4	2	3	3	4	4	–	4	3	–	3	4	3	3	4	–	–	3	–
<i>Agrostis tenuis</i>	–	–	–	5	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Agrostis stolonifera</i>	–	–	–	–	5	–	–	4	–	–	4	–	4	5	4	–	–	–	–	–	5	–	–
<i>Phleum pratense</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	4	–	4	–	3

abundance (Fig. 1). Two samples, 1 and 2, were amalgamated and seven with no shells or low numbers not plotted.

(2) Cluster analysis, by CLUSTAN (Wishart 1982), using only the communities plotted in the sector charts and based on percentages of all shells per sample. The communities were plotted in the order produced by this analysis (Fig. 2), and five groups (FH 1–5) identified using the criterion of Gower (1975). The Shannon-Wiener index of diversity, H' , was plotted alongside (see Pielou 1975 and Magurran 1988 for details).

(3) An assessment of the communities in relation to habitat.

The number of shells (crudely, population density) varies from zero to 540. In the two cases of absence, samples 4 and 21, this can be related to low vegetation height (2 cm). In the

TABLE 2

Flat Holm. Vegetation height (cm) at the molluscan sampling spots, 1–26.

Sample no.	Vegetation height	Description where not <i>Arrhenatherum</i> grassland
1	40	
2	40	
3	20–40	
4	2	Very short grassland
5	–	Rock rubble
6	20–30	
7	20–30	
8	20	
9	10–20	
10	10–20	
11	10–20	
12	10	
13	10–15	
14	35	<i>Rubus</i> scrub
15	30–40	
16	30–40	
17	10–20	
18	20–30	
19	30–50	
20	15–25	
21	2	Very short grassland
22	20–30	
23	3–20	
24	3–20	
25	–	Elder scrub
26	–	Elder scrub

cases of the samples with low numbers, however, there is no apparent related habitat property; big differences between adjacent samples are probably related to very local differences in vegetation structure and litter type close to the ground, and perhaps to plant species, but the analysis was not detailed enough to comment further. The rock-rubble community, sample 5, had exceptionally high numbers.

The groups (or communities) are generally of low diversity with the three same species predominant throughout. The Shannon-Wiener index exceeds 2.0 in two cases only, namely in the elder community, FH 3, and in sample 23 from the Radio Beacon enclosure which has the most diverse vegetation on the island.

Molluscan groups

FH 1. *Oxychilus alliarius* is virtually the only species. Diversity is the lowest of all the groups. All samples from *A. elatius* grassland.

FH 2. *Vallonia costata* is the main species, but others are well represented. Diversity is high. Three samples, 8, 9 and 23, are from *A. elatius* grassland, the other three, 12, 13 and 14, from an area of transitional vegetation, so with the latter at least there is relationship between vegetation structure and molluscan diversity.

FH 3. No one species predominates; diversity is the highest of all the groups. *Discus rotundatus*, virtually absent elsewhere, is characteristic. Curiously, because this group is from the elder, a few of the more traditional xerophiles are present, including *Vallonia excentrica* and *Cer­nuella virgata*.

FH 4. *Lauria cylindracea* predominates; diversity is low. Three of the samples are from *A. elatius* grassland, the other is from rock-rubble.

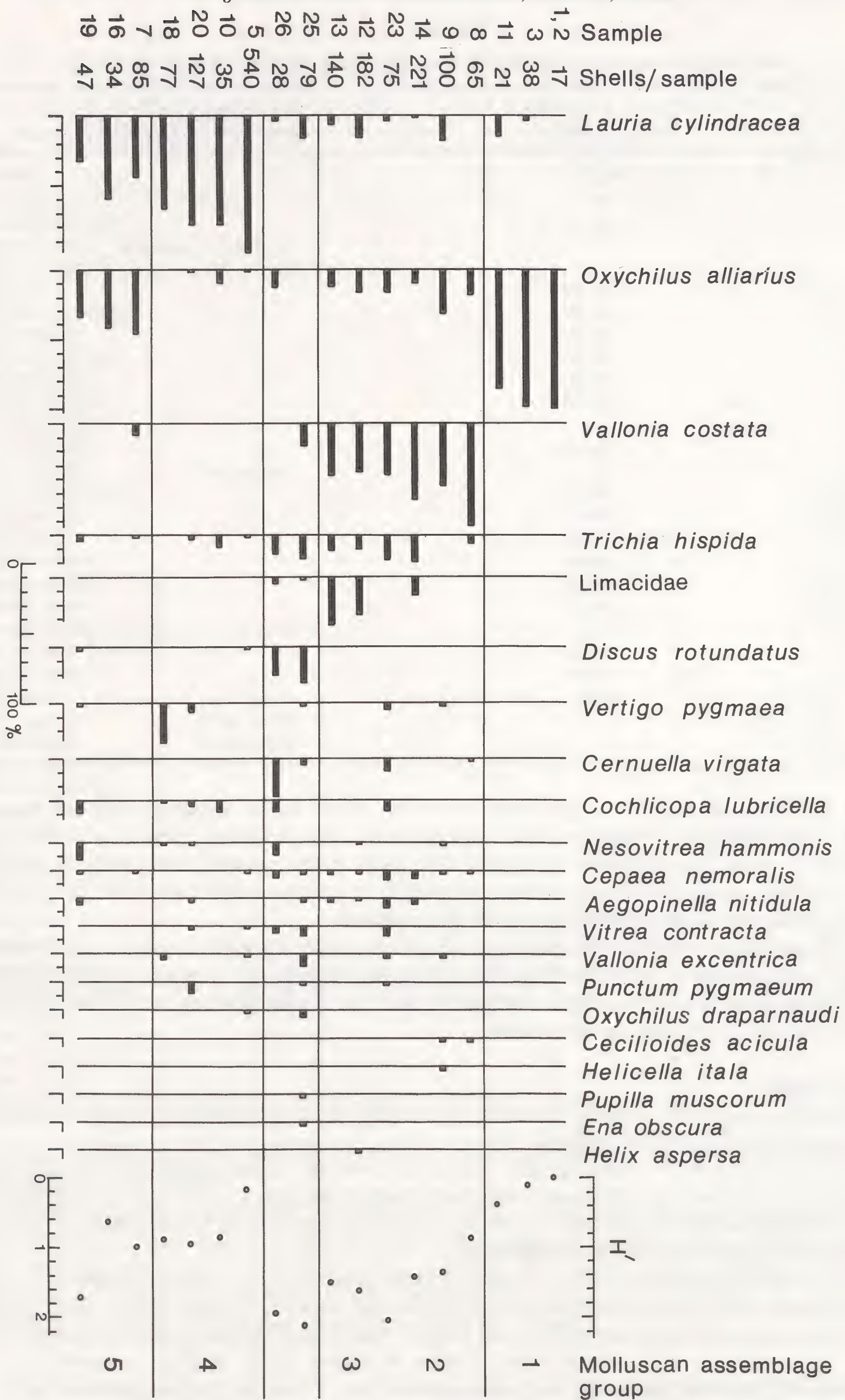


Fig. 2. Molluscan histogram, with sites arranged in the order of the cluster analysis groups.

TABLE 3

Flat Holm. Land Mollusca from sampling spots 1–26. Samples 4 and 21 were devoid of shells.

Sample	1	2	3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	23	24	25	26
<i>Cochlicopa lubricella</i>	–	–	–	–	–	–	–	–	3	–	–	–	–	2	–	–	1	4	4	–	3	–	–	2
<i>Vertigo pygmaea</i>	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	22	1	6	–	3	–	1	–
<i>Pupilla muscorum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
<i>Lauria cylindracea</i>	–	–	1	523	–	37	–	18	27	3	27	9	1	–	20	4	50	15	98	–	2	–	13	1
<i>Vallonia costata</i>	–	–	–	–	8	7	47	43	–	–	62	50	117	–	–	–	–	–	–	–	26	–	12	–
<i>Vallonia excentrica</i>	–	–	–	1	–	–	–	2	–	–	–	–	–	–	–	–	3	–	–	–	1	–	6	–
<i>Ena obscura</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
<i>Punctum pygmaeum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	–	1	–	1	–
<i>Discus rotundatus</i>	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	19	5
<i>Vitrea contracta</i>	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	4	–	4	1
<i>Nesovitrea hammonis</i>	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	1	5	2	–	–	–	–	2
<i>Aegopinella nitidula</i>	–	–	–	–	–	–	–	–	–	–	2	4	8	–	–	–	–	2	3	–	4	–	2	–
<i>Oxychilus draparnaudi</i>	–	–	–	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–
<i>Oxychilus alliarius</i>	5	12	37	2	2	39	12	31	3	18	25	16	19	7	14	1	–	16	1	–	11	–	–	3
Limacidae	–	–	–	–	–	–	–	–	–	–	47	48	26	–	–	–	–	–	–	1	–	–	1	1
<i>Cecilioides acicula</i>	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Cernuella virgata</i>	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	3	7
<i>Helicella itala</i>	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Trichia hispida</i>	–	–	–	1	–	1	3	–	2	–	15	12	40	1	–	–	–	2	2	–	11	1	12	3
<i>Cepaea nemoralis</i>	–	–	–	2	–	1	1	1	–	–	2	1	10	1	–	–	–	1	–	–	4	–	1	1
<i>Helix aspersa</i>	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–

FH 5. *Lauria cylindracea* and *Oxychilus alliarius* are the two main species; diversity is variable. All the samples are from *A. elatius* grassland.

DISCUSSION

The three main species, *Lauria cylindracea*, *Oxychilus alliarius* and *Vallonia costata*, often occur in freshly created habitats such as ditch bottoms, sand dunes and middens, and the general characteristics of the fauna in this respect can be related to the instability of the island’s habitats. There is probably also a relationship with the high nitrogen and phosphate content of the soil and the presence of much decomposing flesh, the last attracting *Oxychilus alliarius* particularly.

There appears to be no relationship between community structure and geographical or topographical location.

Faunal differences can be related to vegetation height (complete absence of molluscs in the short vegetation of samples 4 and 21), structure (high diversity in the transitional vegetation of samples 12, 13 and 14) and special features such as rock-rubble (sample 5) (cf. Evans & Jones 1973) and bare soil and litter under elder (samples 25 and 26).

However, within the main vegetation type, *Arrhenatherum elatius* grassland, there is considerable faunal variation, with all the groups except FH 3 being represented. Without more detailed analysis, the origin of this variation remains elusive, although one may speculate that it is a function of the young nature of the habitats and their instability (cf. Evans & Vaughan 1984).

On a regional scale, it is interesting that many of the more typical species of southern and eastern British grasslands are rare or absent. Such differences could relate to climate – milder winters and more uniform annual precipitation, as suggested for the Malham area by Cameron and Redfern (1972). On the other hand, the differences may also relate to the absence of mature, undisturbed and grazed grassland, and one species characteristic of such

habitats, *Helicella itala*, was recorded, presumably alive, by Wotton (1891), as well as occurring as two subfossil individuals in sample 9. But whatever the causes of these differences, the clear message for people working on archaeological assemblages is that the distinctive grassland faunas of the chalklands are not unique.

ACKNOWLEDGEMENTS

We thank Dennis Bellamy for introducing us to Flat Holm, David Worrall for assistance with the work on the island, and M. S. C. Harvard for assistance with the plant identification.

REFERENCES

- CAMERON, R. A. D. & REDFERN, M., 1972. The terrestrial Mollusca of the Malham area. *Field Studies*, **4**: 589–602.
- CAMERON, R. A. D. & MORGAN-HUWS, D. I., 1975. Snail faunas in the early stages of a chalk grassland succession. *Biol. J. Linn. Soc. Lond.*, **7**: 215–229.
- CHAPPEL, H. G., AINSWORTH, J. F., CAMERON, R. A. D. & REDFERN, M. 1971. The effects of trampling on a chalk grassland ecosystem. *J. appl. Ecol.*, **8**: 869–882.
- CLAPHAM, A. R., TUTIN, T. G. & WARBURG, W. F., 1958. *Flora of the British Isles*. Cambridge University Press, Cambridge.
- EVANS, J. G. & JONES, H., 1973. Subfossil and modern land-snail faunas from rock-rubble habitats. *J. Conch., Lond.*, **28**: 103–129.
- EVANS, J. G. & VAUGHAN, M. P. 1984. The molluscs from Knap of Howar, Orkney. In A. Ritchie, The excavation of a Neolithic farmstead at Knap of Howar, Papa Westray, Orkney. *Proc. Soc. Antiq. Scot.*, **113**: 106–114.
- GILLHAM, M. E., 1963. The vegetation of local coastal gull colonies. *Trans. Cardiff Nat. Soc.* **91**: 23–33.
- , 1984. Botanical skirmish on Flat Holm. *Glam. Nat.*, **9**: 6–7.
- GOWER, J. C. 1975. Goodness of fit criteria for classification and other patterned structures. *Proceedings of the 8th Conference on Numerical Taxonomy*: 38–62.
- HARRISON, S. G. & WADE, A. E., 1976. Unpublished notes on the flora of Flat Holm. *National Museum of Wales, Cardiff*.
- HOPE-SIMPSON, J. F. 1940. On the errors in the ordinary use of subjective frequency estimates in grassland. *J. Ecol.*, **28**: 193–209.
- HUBBARD, C. E., 1954. *Grasses: A Guide to their Structure, Identification, Uses and Distribution in the British Isles*. Penguin Books, Harmondsworth.
- KERNEY, M. P., 1976. *Atlas of the Non-marine Mollusca of the British Isles*. Institute of Terrestrial Ecology, Cambridge.
- MAGURRAN, A. E., 1988. *Ecological Diversity and its Measurement*. Croom Helm, London.
- PIELOU, E. C., 1975. *Ecological Diversity*. Wiley, New York.
- SALMON, H. M., 1957. The new gull colony on Flat Holm. *Bristol Naturalists' Society* (Fieldwork review section), **8**: 4–5.
- VERNON, J. D. R., 1959. The breeding population of gulls in Glamorgan and Monmouthshire. *Trans. Cardiff Nat. Soc.* **88**: 14–18.
- WISHART, D., 1982. *Clustans Users Manual*. (3rd edn.) Programme Library Unit, Edinburgh University, Edinburgh.
- WORRALL, D. H. & SURTEES, P. R., 1984. *Flat Holm Island*. South Glamorgan County Council.
- WOTTON, F. W., 1891. A short historical account of the Flat Holme and its natural history. *Trans. Cardiff Nat. Soc.*, **22**: 105–11.

BRIDGING THE GAP: *PARENNEA* (PULMONATA:STREPTAXIDAE) IN NIGERIA

A. C. VAN BRUGGEN¹

(Accepted for publication, 22nd April, 1991)

Abstract: A record from Nigeria of *Ptychotrema* (*Parennea*) *aequatoriale* bridges the gap in the distribution of the subgenus formed by the area between Gabon and Liberia. This represents a range extension westward of c. 1500 km.

In 1978 Adam and Van Goethem reviewed the streptaxid taxon *Parennea* Pilsbry, 1919, a subgenus of *Ptychotrema*. In 1989 the present author published additional studies on this group (Van Bruggen 1989). In a biogeographical analysis on pp. 51–54 (Figs. 45–46) he drew attention to a noticeable gap in the distribution in West Africa – there were no records from the area between Gabon in the east and Liberia in the west. “Absence in this area is probably due to lack of collections rather than representing a natural pattern.” (Van Bruggen, *op. cit.*: 53). That this is indeed the case, was recently shown by a record from Nigeria. In 1990 Mr. Chris Oke, a student of Prof. W. O. Odiete (University of Lagos), submitted for identification a mixed lot of land snails, among which was a shell of *Ptychotrema* (*Parennea*) *aequatoriale* Pilsbry, 1919. This specimen was obtained at Kwale in Bendel State, Nigeria, which, according to correspondence with Mr. Oke, is in the forest zone of southern Nigeria. The shell measures 3.9×2.1 mm with $6\frac{1}{4}$ whorls, and is now preserved in the Leiden museum. The identification was confirmed by comparison with authenticated material from Adam and Van Goethem in the Brussels museum; the specimen is typical in all respects. A corrected Fig. 45 of the 1989 paper is appended (Fig. 1) to show the position of the new locality.

Incidentally, the new record represents a considerable extension westward of the distribution of *Pt. (Par.) aequatoriale*. The species is known to occur in northern and north-eastern Zaïre and adjoining parts of Uganda; the two previous westernmost localities known were Boteke ($0^{\circ}12'S$ $18^{\circ}55'E$) and Bozene ($3^{\circ}00'N$ $19^{\circ}21'E$), both in Zaïre. Kwale (west of the Niger R. at $5^{\circ}49'N$ $6^{\circ}24'E$) is about 1500 km distant for Boteke. This may seem to be an enormous range extension, but may almost be considered routine for the student of African land snails – even an optimist would call our knowledge of the distribution of these gastropods, particularly that of the smaller ones, fragmentary.

REFERENCES

- ADAM, W. & VAN GOETHEM, J. L., 1978. Révision du sous-genre *Parennea* Pilsbry du genre *Ptychotrema* Mörch (Mollusca – Pulmonata – Streptaxidae). *Études Cont. Afr. Bruxelles*, **5**: 1–79.
BRUGGEN, A. C. VAN, 1989. Studies on *Parennea* (Mollusca, Gastropoda Pulmonata, Streptaxidae) additional to the revision by Adam & Van Goethem, 1978. *Proc. K. ned. Akad. Wet. (C)*, **92**: 1–56.

¹ Systematic zoology section of the university, c/o National Museum of Natural History, P.O. Box 9517, 2300 RA Leiden, the Netherlands.

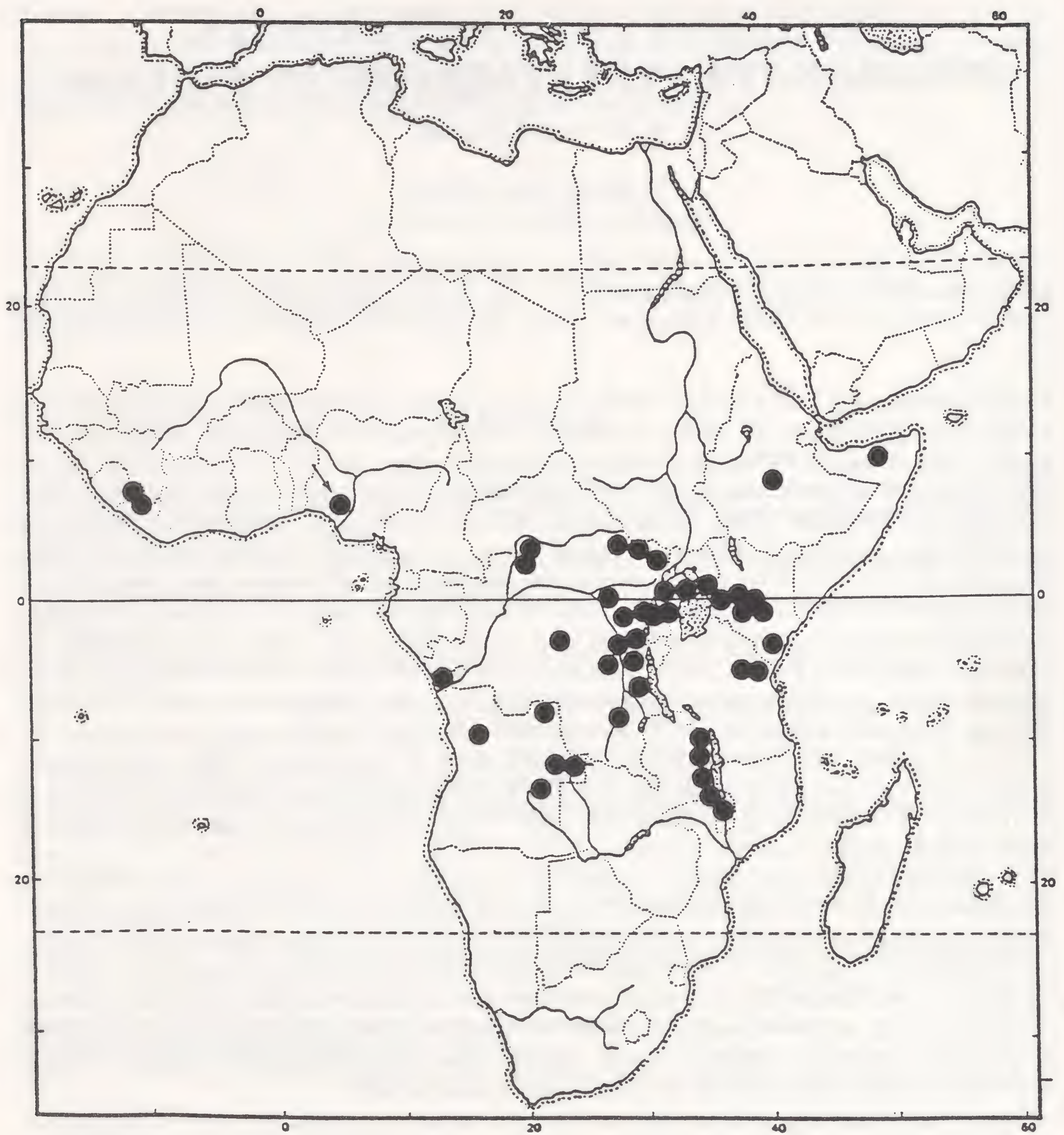


Fig. 1. Distribution of *Parennea* with the new locality indicated by an arrow (modified after Van Bruggen 1989, Fig. 45).

CORIOCELLA HIBYAE SP. N. A NEW *LAMELLARIA* SPECIES (GASTROPODA: PROSOBRANCHIA) FROM THE REPUBLIC OF THE MALDIVES

W. WELLENS¹

(Accepted for publication, 22nd April, 1991)

Abstract: *Coriocella hibyae* is described based upon 7 live-collected specimens in the Maldives. The species resembles *Chelyonotus semperi* Bergh, 1886, but differs from this latter by the general form, the shell and the radula.

INTRODUCTION

During a journey in the Republic of the Maldives in 1984, Mrs I. Hiby found a large nudibranch-like animal. The specimen was collected at a depth of 1 metre on a coral reef. At first glance the species was considered to be a nudibranch. However, after several months of fixation in alcohol, we remarked a sharp protuberance under the surface of the dorsum. An X-ray photograph showed that this projection was caused by the apex of an auricular shell, which indicated that our specimen was probably a lamellarid or shelled opisthobranch. After a scrutiny of the literature, we found only one lamellarid species showing some resemblance with our animal viz *Chelyonotus semperi* Bergh, 1886. Since there were several conspicuous differences between this species and ours, we decided to describe our material as a new species.

Abbreviations used:

- | | |
|---------|--|
| K.B.I.N | Koninklijk Belgisch Instituut voor Natuurwetenschappen |
| Z.M.C | Zoological Museum of Copenhagen. |
| Z.M.A | Zoological Museum of Amsterdam. |
| M.N.H.N | Muséum National d'Histoire Naturelle Paris. |

MATERIAL EXAMINED

From the Maldives.

- sp M 113 holotype length 35 mm. Female
- sp M 68bis paratype length 55 mm. Male.
- sp M 68 paratype length 40 mm. Female.
- sp M 73 paratype length 48 mm. Male.
- sp M 89 paratype length 50 mm. Female.

These specimens were collected north of Baros island in the North Malé Atoll by M. Goldstein and J. Van Goethem in 1976.

- sp Hiby paratype length 45 mm. Female.

collected on the west side of the island Embudu in the South Malé Atoll in December 1984.

¹ K.B.I.N Malacology Section, Vautierstraat, 29 B–1040 Brussels, Belgium.

sp Gerlo paratype length 60 mm. Female.

collected on the east side of the island Embudu in November 1989.

All the type material was found, by day, on the sandy bottom of coral reefs in shallow water at a depth of about 1 metre. All the specimens are now deposited in the collections of the K.B.I.N.

From other localities.

C. hibyae was compared with *C. semperi* from the following localities:

1 specimen from the Philippines collected in 1884 (ZMC)

3 specimens from the Kai islands collected in 1922 (ZMC)

19 specimens from Indonesia collected in 1889–1900 (ZMA)

Because all the specimens, received as loans, had been preserved for about a century, we decided to search for living animals. We travelled to the Moluccas (Indonesia) because the literature indicated that most of the specimens of *C. semperi* were captured there.

We collected 4 living specimens in Southeast Maluku in November 1989:

1 specimen on the east side of the island Saparua near Mahu. Male.

1 specimen on the west side of the little Kai Island near Labetawi. Male.

2 specimens on the east side of the same island near Disuk. Male and female only separated by 1 m from each other.

These four specimens, about 6 cm long and 3.5 cm broad, were found on the sandy bottom of coral reefs in shallow water at a depth of about 1 metre, by day.

The 4 specimens are now deposited in the collections of the K.B.I.N.

DESCRIPTION OF *CORIOCELLA HIBYAE* N.SP

(Pl. 7, Fig. 2)

The holotype is 35 mm long. The round body has one big bulbous boss with a diameter of 10 mm in the middle of the dorsum and four similar bosses situated around the central boss as four “pseudolimbs”. The posterior end is short and straight. The head has short simple brown tentacles with the eyes at their outer bases. The sole is dark green and occupies about

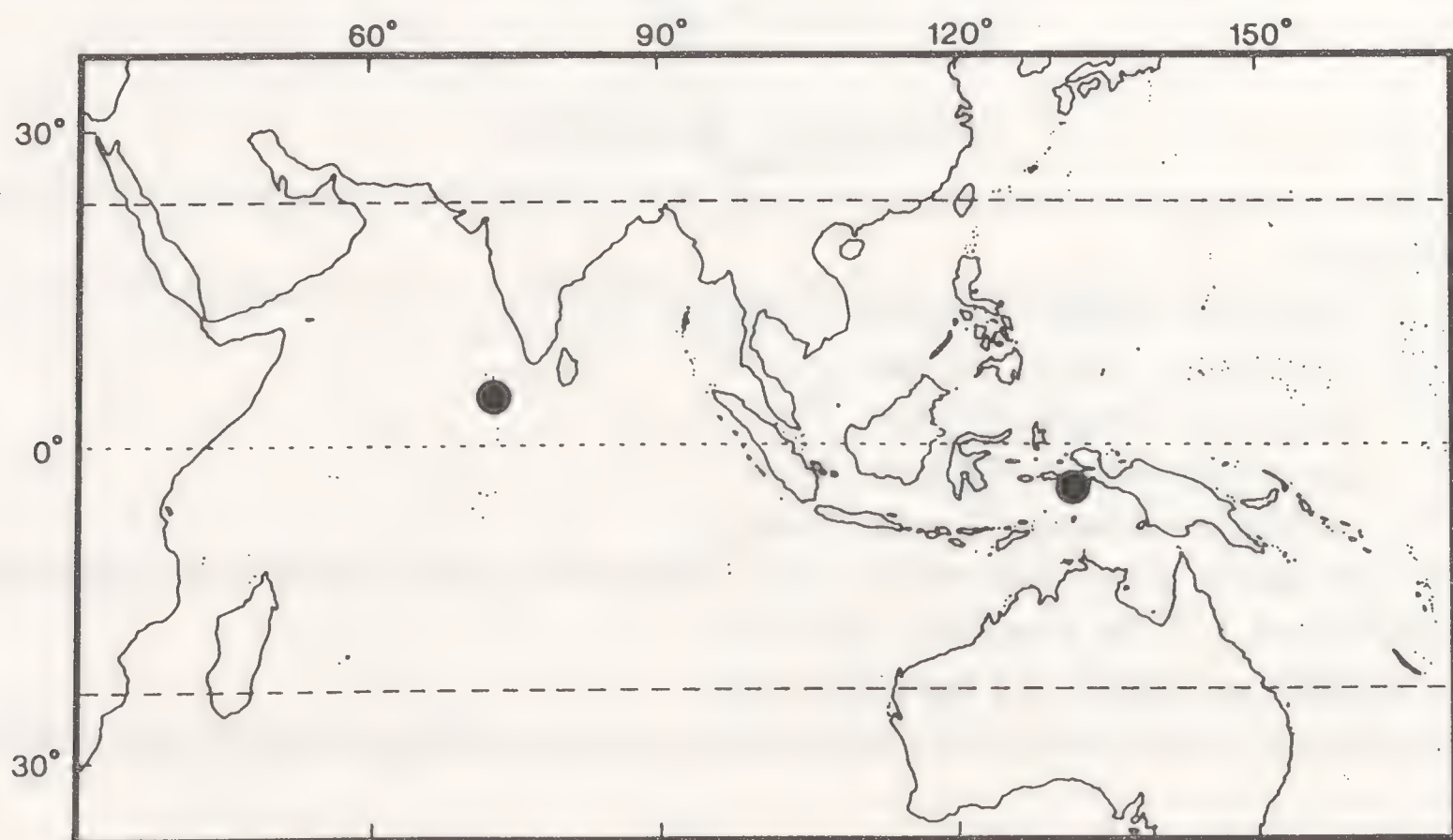


Fig. 1. Distribution of *Coriocella hibyae* n.sp and *Chelyonotus semperi* (see text).

half the total length of the animal. The sole width decreases posteriorly. Anteriorly there is a marginal groove in which the pedal gland is situated. The surface of the dorsum and the bosses is smooth. The live animal has a uniform dark green colour.

The maximum length of the shell (Fig. 2), measured on an X-ray photograph is 19 mm. The triangular monopectinate gill consists of about 50 lamellae. The osphradium, situated on the left side in the inhalant siphon, is oval and bipectinate; it has fewer lamellae. The jaw plates have a length of 3.54 mm and a breadth of 3.16 mm. The radula (Pl. 7, figs. b-f) with a length of 27.87 mm and a breadth of 1.2 mm has about 60 rows of teeth formula O.I.I.I.O.

The thin, fragile and auricular shell is smooth and transparent white in colour; growth lines are visible. The spire is obtuse and small; purer white in colour than the other whorls. There are $3\frac{1}{2}$ rounded whorls; the suture is impressed; the body whorl is very large. The aperture is transversely oval and very wide (19×15 mm) with a thin white callus along the

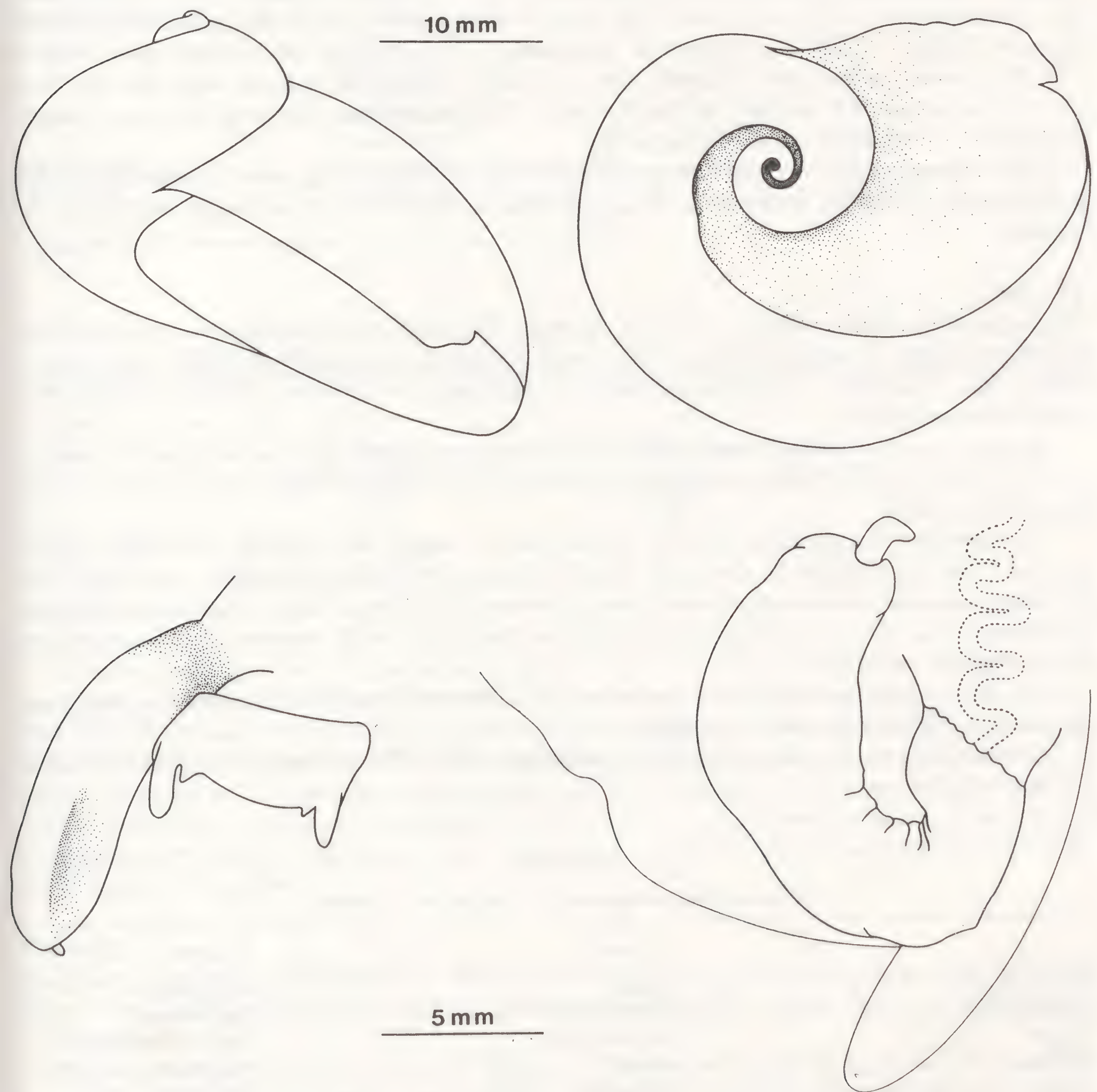


Fig. 2. *Coriocella hibyae* n.sp. Shell (top) and penis (bottom).

inner lip with a sharp non reflected outer lip. The columella is open so that the inner cavity of the protoconch can be seen when looking within the umbilicus.

The penis (Fig. 2) is about 20 mm long and 5 mm broad. It projects behind the right side of the head and, in a preserved state, runs almost parallel with the direction of the tentacles making a wide curve to the ventral side.

The external end of the vas deferens protrudes about 2 mm from the penis tip. From the base of the penis runs the male duct enclosed in the body wall.

DISCUSSION

The animal.

Table 1 compares the general form, the proportion between the dorsum and the bosses and the colouration of the two species. The most striking difference is the morphology of the dorsum. Bergh's (1886) description is meticulous: "The dorsum has a black velvet colour and blue linear arches are designed concentrically around the central boss and the four peripheral bosses. The surface of the dorsum is divided by anastomosing furrows in larger and smaller irregularly vaulted fragments".

The appearance of the dorsum prompted Bergh to choose the name *Chelyonotus* for his new species. *Chelinotus* Swainson, 1840 indicates the resemblance with the dorsum of the tortoise.

The shell

The form of the shell is similar in the two species. The number of whorls in lamellarid shells is rather variable. *L. utinomii* Taki (1972) has $2\frac{3}{4}$ whorls. *L. diegoensis* Dall (1885) according to Abbott has 3 whorls. *L. perspicua* Linnaeus (1758) has 2 to 3 whorls (Marcus 1986), or 3 whorls (Keen 1971).

It appears also that the ratio between the maximum length of the animal and its shell is very variable. In Table 2 we notice that the length of the animal varies from $1.3\times$ to $3\times$ the length of its shell.

To compare this ratio between *C. hibyae* and *C. semperi* we selected 4 animals of each species with approximately the same length. Because the internal shell is very fragile we decided to do the measurements on X-ray photographs. From Table 3 we notice that the specimens of *C. hibyae* are about twice as long as their shell, while specimens of *C. semperi* are about 3 times as long.

The X-ray photographs of the specimens of *C. hibyae* showed a better shell contrast than the shell of the specimens of *C. semperi*.

The shells from two paratypes of *C. hibyae* dissected in 1988 are still perfectly intact in the alcohol solution.

TABLE 1
Comparative morphology of *C. hibyae* and *C. semperi*.

	<i>C. hibyae</i>	<i>C. semperi</i>
General form	round	spool-shaped
Posterior end	short-straight	long-rounded
Bosses	large-bulbous	small-cylindriform
Surface	smooth	vaulted irregular fields
Colour	dark green	black velvet fields blue lines.

WELLENS: A NEW *LAMELLARIA* SPECIES

TABLE 2

Literature survey of ratios between maximum body and shell lengths in some lamellarid species.

References	Species	Measurements (mm)		Ratio
		Body	Shell	
Bergh (1886)	<i>C. semperi</i>	75	20·5	3·75/1
Tryon (1886)	<i>L. tongana</i>	85	28	3/1
Marcus (1956)	<i>L. perspicua</i>	male 9	7	
		female 10	8	1·3/1
Allan (1958)	Species A	76	27	3/1
	Species B	42	22	2/1
	Species C	38	11	2/1
	Species D	male 12·7	6	1·3/1
		female 25·4	10	1·3/1
Van Bruggen (1966)	<i>L. mauritiana</i>	60	41	1·5/1
Taki (1972)	<i>L. utinomii</i>	55	27·5	2/1
Behrens (1980)	<i>L. inflata</i>			
	largest between			
	23 specimens*	6	4–5	1·5/1
	<i>L. diegoensis</i>			
	largest between			
	45 specimens*	45	15–20	2·2/1
Marcus (86/87)	<i>Coriocella nigra</i>	48	20	2·4/1
This paper	<i>C. hibyae</i> n.sp	35	19	1·8/1

* completed with measurements of the shells from Abbott, 1954.

TABLE 3

Comparison of maximum body length and maximum shell length between 4 specimens of *C. hibyae* and *C. semperi* with the same length. In mm.

Maximum body length	Maximum shell length	
	<i>C. hibyae</i>	<i>C. semperi</i>
55	28	17
50	26	17
45	25	13
40	22	11

The shells of the four specimens of *C. semperi* captured alive in Southeast Maluku, were dissected in December 1989 and preserved in the same alcohol. Six weeks later we noticed that 50% of the last whorl had disappeared except for the periostracum. In 1886 Bergh wrote about the shells of *C. semperi*: “By some specimens the calcification of the last whorl is too little continued or at least the calcification on the peripherie is not completed”. Marcus (1957) also wrote: “A weak calcification of the shell however is not a generic character of *Marseniella* as it occurs in *Lamellaria* too”. Apparently the shells of *C. hibyae* dissolve less easily than those of *C. semperi*.

The radula

Radulae from four specimens of *C. hibyae* (collection K.B.I.N) 55, 50, 45 and 40 mm long have been compared with four radulae from specimens of *C. semperi* with the same length (Table 4).

The radulae of the specimens of *C. hibyae* are longer and wider than those of *C. semperi*. Light microscopy showed in both species a reduced taenioglossate radula: the central tooth is accompanied by one lateral tooth on each side: formula I.I.I.

TABLE 4

Comparison of the dimensions of the radula in mm and teeth rows per cm radula by 4 specimens of *C. hibyae* and *C. semperi* with the same body length.

	<i>C. hibyae</i>	<i>C. semperi</i>
body length	55	55
radula length	34	20
breadth	1.2	1.1
rows per cm	21	40
body length	50	50
radula length	38	18
breadth	1.2	1
rows per cm	25	40
body length	45	45
radula length	28	16
breadth	1.2	0.8
rows per cm	24	40
body length	40	40
radula length	27	15
breadth	1.2	0.8
rows per cm	22	36

The radulae from the specimens of *C. hibyae* have about 20 rows of teeth in 1 cm length; this is about half the number of rows in the specimens of *C. semperi*.

A SEM micrograph was made of the middle third of the radulas. The rachidians are Δ shaped (Pls. 7 & 8). The left leg of the bifurcate base is more developed. The central teeth are obliquely implanted on the membrane of the radula. Taki (1972) noticed that the “distortion” of *L. utinomii* measures about 10° in angle with the median longitudinal axis. We measured, on the 8 radulas studied, a distortion between 20° and 40°.

Both the right and left outer sides of the rachidians showed about ten minor denticles placed on equal distances from each other. The average measurements of 14 rachidians from the two groups are given in Table 5.

Generally the rachidian of *C. hibyae* is broader than that of *C. semperi*.

The right and left teeth have similar shapes in both species. They are obliquely implanted on the radula membrane and have a conspicuous central ridge which projects externally as a “canine tooth”.

The inner flanking cusp bears six denticles, equally distributed over almost the breadth of the lateral tooth. The outer flanking cusp, reaching the middle of the stem, bears about twenty joined denticles which are very small in size.

The average measurements of 12 lateral teeth from each of the two groups are given in Table 6.

The lateral teeth of specimens of *C. hibyae* are more slender than those of *C. semperi*.

TABLE 5

Comparison of the average measurements of 14 Rachidians of *C. hibyae* and of *C. semperi*. In mm.

	<i>C. hibyae</i>	<i>C. semperi</i>
Base	0.450	0.257
Height	0.257	0.215

TABLE 6

Comparison of the average measurements of 12 lateral teeth of *C. hibyae* and of *C. semperi*. In mm.

	<i>C. hibyae</i>	<i>C. semperi</i>
Maximum length	1	0.722
Maximum breadth	0.274	0.223

Etymology. Hiby is the name of my wife and dive buddy who found the specimen that started this study.

CONCLUSION

Although *C. hibyae* shows a certain resemblance with *C. semperi*, this new species is clearly distinct by its general form and colour, its smooth surface and the volume and configuration of the 5 bosses.

The maximum body length of *C. hibyae* is about twice the maximum length of the shell.

The radulae differ in length and breadth and by the number of rows per cm length. The teeth show differences in size and size ratios.

In 1931 Thiele wrote that *Coriocella* Blainville, 1824 is a synonym for *Chelinotus* Swainson, 1840 and for *Chelyonotus* Bergh, 1853 because their male duct is enclosed in their body wall. Because *Coriocella* is the oldest name and because our species presents the same anatomical particularity we have assigned our new species to the genus *Coriocella*.

ACKNOWLEDGEMENTS

I am indebted to Dr. J. Van Goethem (K.B.I.N) for providing me with working facilities and for supervising this study. Thanks are further due to Dr. J. Knudsen and Dr. T. Schiotte (both Z.M.C), to Dr. G. Moolenbeek (Z.M.A) and to Dr. P. Bouchet (M.N.H.N) for sending as loans the required specimens. Dr. W. Sleurs (K.B.I.N) helped with the preparations of the radulae and Dr. T. Backeljau (K.B.I.N.) dissected the penis. For technical help thanks are due to Mr. A. Lievrouw, Mr. J. Cillis and Mr. H. Van Paesschen (K.B.I.N). I thank my colleague Dr. T. Gerlo for procuring a specimen of *C. hibyae* from the Maldives. Finally I am indebted to Dr. J. Van Goethem and Dr. T. Backeljau for commenting on the manuscript.

REFERENCES

- ABBOTT, R. T., 1954. *American Seashells*. Van Nostrand. D.
- ALLAN, J., 1958. Some species of Lamellariidae (Class Gastropoda) from the Eastern Australian coast. *J. malac. Soc. Aust.*, **2**: 48–57.
- BEHRENS, D. W., 1980. The Lamellariidae of the North Eastern Pacific. *The Veliger*, **22**: 323–339.
- BERGH, R., 1886. *Reisen im Archipel der Philippinen von Dr. C. Semper*, Zweiter Band: Malacologische Untersuchungen. Wiesbaden; C. W. Kreidel's Verlag.
- , 1905. *Die Opisthobranchiata der Siboga Expedition*. Leiden.
- KEEN, M., 1971. *Sea Shells of Tropical West-America. Marine Mollusks from Baja California to Peru*. Stanford University Press, California.
- MARCUS, E., 1956. On some Prosobranchia on the coast of Sao Paulo. *Bol. Inst. Oc.*, **7**: 3–28.
- , 1986/1987. On *Coriocella nigra* (Blainville, 1824) (Gastropoda. Prosobranchia Lamellariidae) from the Gulf of Elat. *Israel J. Zool.*, **34**: 1–11.
- TAKI, I., 1972. On a new species of *Lamellaria* (*L. utinomii*, n. sp) from Shirahama, Wakayama Prefecture, Japan. (Moll, Gastropoda) *Publ. Seto. Mar. Biol. Lab.* **21**: 1–12.

THIELE, J., 1931. *Handbuch der Systematischen Weichtierkunde*. Jena-G. Fischer Verlag.

TRYON, G. W., Junior, 1886. *Manual of Conchology* 8. Philadelphia.

VAN BRUGGEN, A. C., 1966. A note on *Lamellaria mauritiana* (Gastropoda-Prosobranchia) in South-Africa. *Basteria*, **30**: 15-18.

PLATE 7 (opposite)

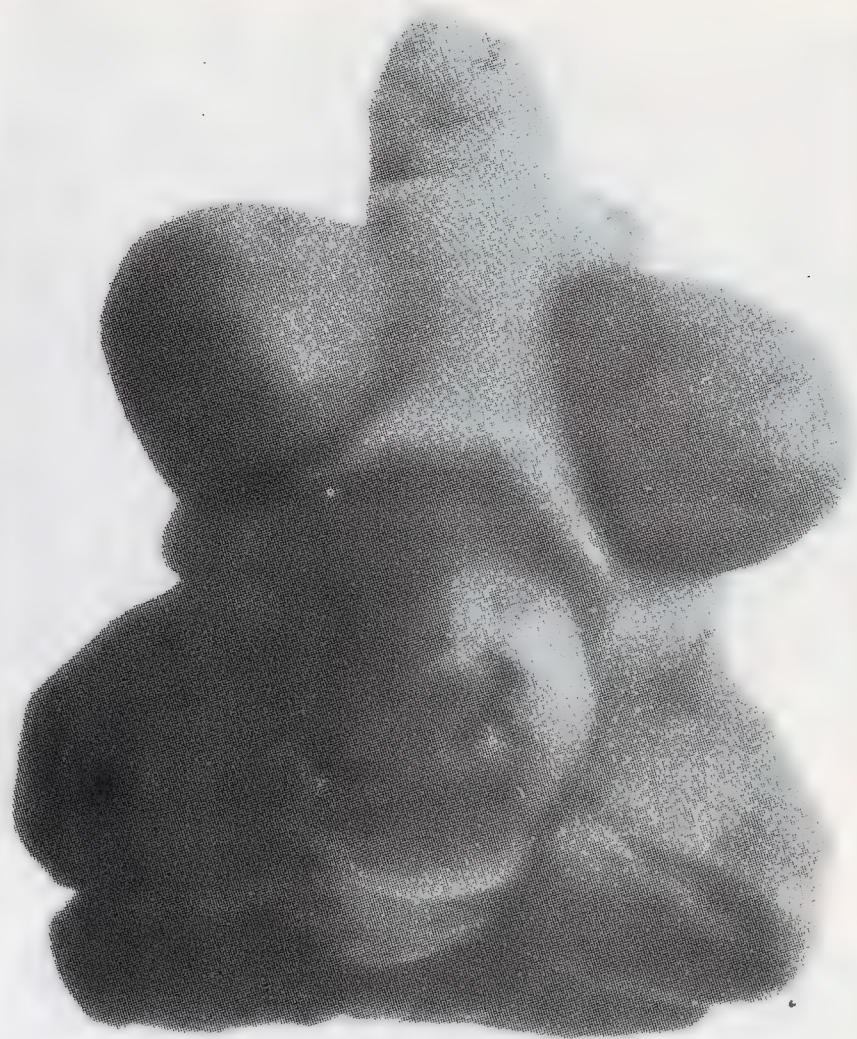
(a) *Coriocella hibyae* from the Maldives. Collection K.B.I.N. Brussels. Holotype M II3 ex.alc. Length 35mm.

Radula of *C. hibyae*

(b) Part of radula: magnification 55 x scale 0, 1 mm (c) Rachidian: magnification 212 x scale 0, 1 mm (d) Top of Rachidian: magnification 482 x scale 0, 1 mm (e) Lateral teeth: magnification 106 x scale 0, 1 mm (f) Top lateral teeth: magnification 186 x scale 0, 1 mm.

WELLENS: A NEW *LAMELLARIA* SPECIES

(a)



(b)



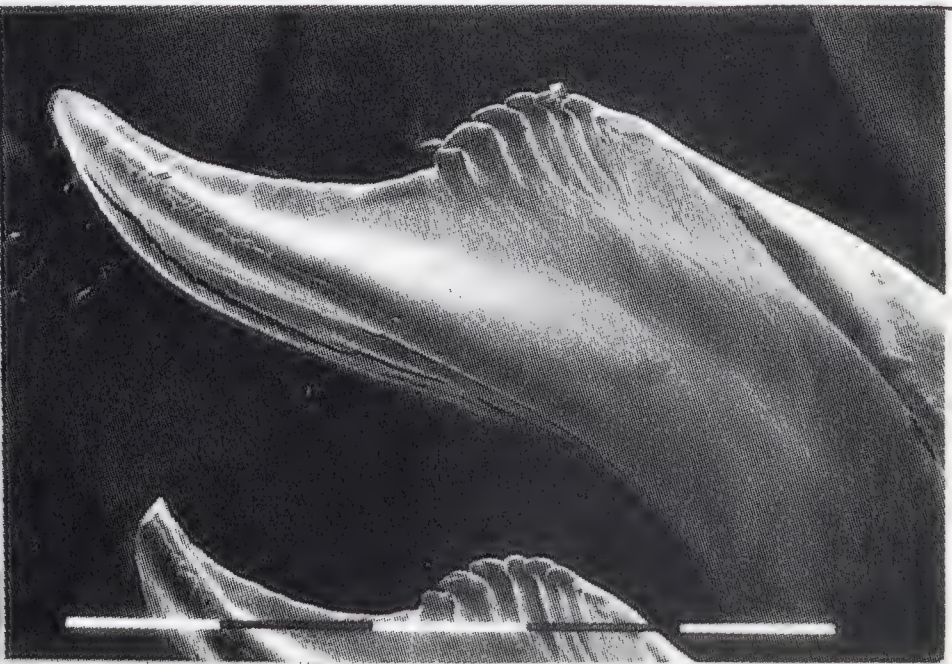
(d)



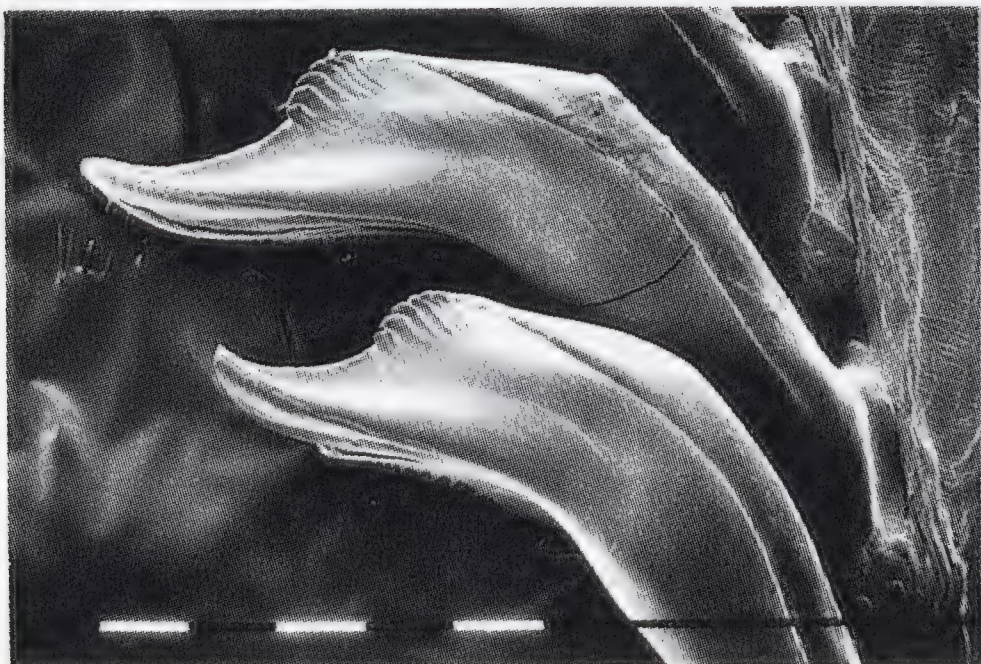
(c)



(f)



(e)



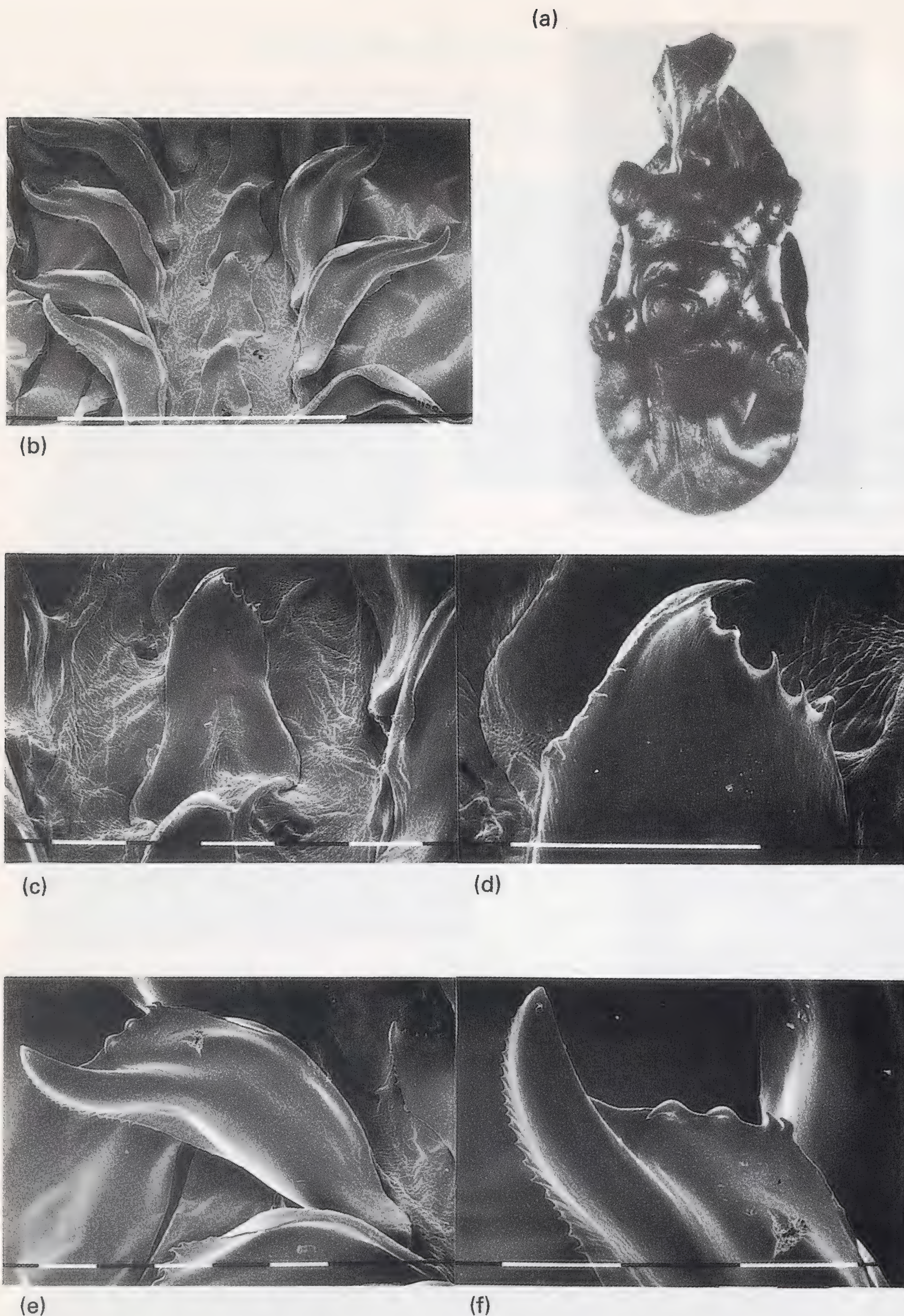


PLATE 8

(a) *Chelyontus semperi* Bergh, 1886 from Indonesia. Collection Zoological Museum Amsterdam. Siboga Expedition station 258 ex.alc. Length 65mm.

Radula of *C. semperi*

(b) Part of radula: magnification 75 x scale 1 mm (c) Rachidian: magnification 194 x scale 0, 1 mm (d) Top of Rachidian: magnification 655 x scale 0, 1 mm (e) Lateral teeth: magnification 150 x scale 0, 1 mm (f) Top lateral teeth: magnification 312 x scale 0, 1 mm.

A NEW *ANOSTOMA* FROM BRAZIL (GASTROPODA: PULMONATA: BULIMULIDAE)

BERNARD VERDCOURT¹

(Accepted for publication, 20th October, 1991)

Abstract: *Anostoma octodentatum brunneum* is described from Goias State, Brazil.

I have already given a good deal of background information concerning this genus (Verdcourt 1990) but the undescribed taxon mentioned in the *Conchologists' Newsletter* needs formal description. It has been agreed, quite rightly, that the Newsletter is an inappropriate place for such descriptions.

*Anostoma octodentatum** *brunneum* Verdcourt. n.ssp. (Fig. 1) differing from the typical subspecies in its dark brown colouration including the peristome and aperture with the teeth paler or quite white.

Shell depressed globose, biconvex, somewhat oblong in plan, distinctly keeled; body whorl with narrow darker band above the keel and narrower one above below the suture, the keel itself more or less pale and base densely blotched. Whorls 5; sculpture (taken from the juvenile shell): protoconch almost smooth with only very obscure transverse marks, rest with strong close irregularly interrupted transverse rugae, spiral element not very evident on upper 3 whorls but from there on with about 15 fine spiral lines irregularly spaced and traces of fine lines between them; base with more regular closer raised spiral lines; sculpture soon worn down in adult shells; peristome thickened and strongly reflexed. Dentition variable, the holotype with 7 labial lobes similar to the figure given by Pilsbry (1901, t. 64, fig. 43) but including an obscure additional one between the paired group and the basal lamella, and 3 parietal lobes the upper pair in planes at right angles to each other, actually joined and not separate as in Pilsbry's figure; the adult paratype has the same parietal arrangement but only 5 labial lobes arranged as in Pilsbry's Fig. 40.

Alt. 16 mm, greater diam. 33–34 mm, lesser diam. 24–26 mm. A juvenile paratype 21.5 × 20 mm has a perfectly regular uniformly brown circular very depressed shell with the periphery very sharply keeled and sculpture very clear; the umbilicus is deep, 5 mm wide and is of course later entirely covered by the change of direction of growth undergone by the body whorl.

Type locality: Brazil, Goias State, about 20 km SE. of Dianopolis, near Jardim, 46° 40' W., 11° 50' S., on calcareous rock outcrop with relict woodland, 12 Feb. 1987, leg. R. M. Harley.

Holotype: British Museum (Nat. Hist.), London BMNH 1990 124. Paratypes: one juvenile in BMNH 1990 126, one adult in Museum of Zoology, University of Sao Paulo (all in spirit).

I am not at all convinced of the specific distinctness of the three accepted species included in the group of *A. octodentatum*. Certainly the dentition can vary very considerably in one group of specimens. Nothing can be done with the available material since it cannot be

¹ c/o Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB.

*Fischer von Waldheim, Museum-Demidoff, ou catalogue – Demidoff 3: 230 (1807).

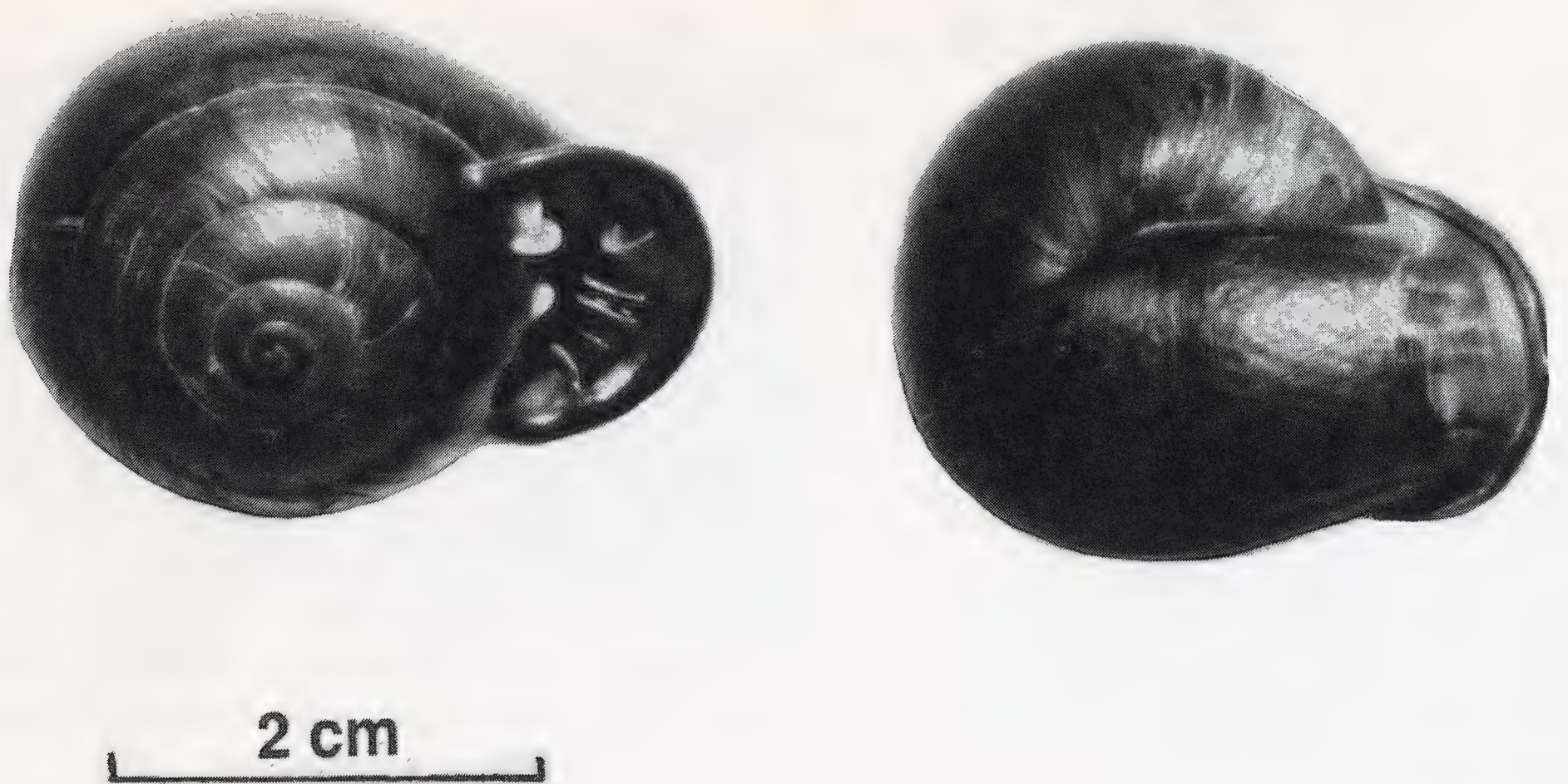


Fig. 1. *Anostoma octodentatum brunneum* subsp. nov. Brazil, Goias State. Holotype.

sorted geographically. Probably every major museum in the world has a few specimens, almost all without accurate data. It is likely that much good material rests in Brazilian museums but attempts to find out have been unsuccessful.

REFERENCES

- VERDCOURT, B., 1990. Notes on *Anostoma*. *Conch. Newsl.* **115**: 326–329.
PILSBRY, H. A., 1901. *Manual of Conchology*, ser. 2, vol. 14. Philadelphia.

REVIEWS

Distribution of the Marine Molluscs of North West Europe. Compiled by D. R. Seaward. Nature Conservancy Council, in association with the Conchological Society, 1990. ISBN 0 86139 681 2. 114 pp. Price £9.50.

When is an atlas not an atlas? When it has no maps and, in the present case, it is a supplement and amendment to a previously published series of maps: the 1982 *Sea Area Atlas of Marine Mollusca of Britain and Ireland* by the same compiler and publisher. The present work is, however, more than just a set of corrections and additional records, not least because the geographical area covered has been extended to include much of the north western tip of Europe – from Bergen in Norway to Brest in Brittany, and from the west coast of Denmark to the Faeroes, Rockall and Labadie (but not Porcupine) in the open Atlantic.

As previously, mapping is by the Sea Areas System adopted for the Conchological Society's marine recording scheme, now extended by 10 to 53 Areas ranging in size from the minute 'Boulogne Coast' to the huge 'Rockall' and 'Fisher'. References to these mapping units in the text are by code letters and numbers, so that, for example, the entry for *Hydrobia neglecta* reads:

Map: S17† ([ref.]). Dist: above and S3, S12, S13, S36, S29, S30; S32 ([ref.]). Probably under-recorded, but absent from S51 ([ref.]). Brackish water.

where the entries after 'Map:' indicate an update of the *Atlas* and those after 'Dist[ribution]:' give the complete range within the area covered. The † symbol equates with the solid circle of the *Atlas*, as does @ with the half-filled circle, and ¢ with the open one. Besides the pages of such distributional data, there is a 14 page bibliography and an 8 page index to genera and higher taxa.

The comment by Roger Mitchell in his Preface on behalf of the N.C.C. congratulating Dennis Seaward (to whom all further records and other information should be sent) on his meticulous work in preparing this compilation can only be warmly echoed by this reviewer. Wearing the hat of a brackish-water biologist, he would also like to add personal appreciation of the inclusion of a number of brackish-water species, such as *Potamopyrgus jenkinsi*, that are often omitted from works devoted to marine molluscs (as indeed *P. jenkinsi* was from the *Atlas*) notwithstanding that they occur in coastal saline waters like lagoons.

The format illustrated above for *H. neglecta* undoubtedly permits the maximum information to be presented in the minimum space – so that 1000 species can be treated in just over 77 pages – but it does require constant back-reference to the key map of Sea Areas and their identification codes to gain any real information on occurrence. Perhaps one day we can look forward to all the information contained in this book being incorporated into another edition of the *Atlas* itself. Until then, all users of the original *Atlas* (some copies of which are still available) will need a copy of this enlarged supplement, as indeed will all those concerned with the distribution of north west European molluscs.

R. S. K. BARNES

Weichtiere By Rosina Fechter and Gerhard Falkner. Published by Mosaic, Munich in 1990. 287 pp, 740 colour photographs. ISBN 3–570–03414–3 Price 26 DM.

This attractively presented pocket-sized hardback covers 660 species of European marine and non-marine molluscs. The text is in German, but for those who do not read German, it is useful for the colour photographs alone. These include smaller species of non-marine molluscs not often illustrated photographically, making this book a welcome addition to the library.

After a short introduction to molluscs, information is presented as double page spreads with numerous good colour photographs and captions alongside. Colour-coded tabs in the top right hand corner help to separate the different sections of the book for ease of use in the field. It covers the whole of Europe south to the Mediterranean and including the eastern countries. The book concludes with a glossary of terms, list of further reading and details of societies in Germany. The end boards have an attractive snail design.

The text for each marine species is clearly laid out into categories – diagnostic description (Merkmale), habitat and distribution (Lebensraum), way of life (Lebensweise) and reproduction (Fortpflanzung) and all are concise. There are more species of marine than non-marine species living in Europe, especially with the inclusion of the rich Mediterranean fauna. Perhaps the book is targeted for use mostly in Germany which has little shoreline, for there are only 86 pages devoted to marine species, therefore many common and most small-sized species are omitted while the opisthobranchs are reduced to only two double page spreads. There is no mention of recently recognised species of *Littorina*. The colour photographs are clear and will be useful – some are shells, others of live animals.

More economical use of space is made in the non-marine section (Binnenmollusken) which packs an amazing amount of information into 161 pages. The book will be particularly useful for the freshwater section with the European species of *Theodoxus* and other prosobranchs like *Bythinella* that are not on the British list. Slugs are realistically portrayed as colour photographs, while those of snails show the shells from several viewpoints as well as the living animals in some cases. These are particularly useful in species of the Vitrinidae and *Oxychilus* where body colour is a diagnostic feature. As is to be expected in a book originating on the Continent there is good coverage of the Clausiliidae which are well represented in the eastern countries of Europe.

The notoriously difficult small freshwater bivalves of the genus *Pisidium* are usually omitted at species level in elementary books. In the bivalve section the plate showing a range of *Pisidium* species portrays the differences in shell outline that are useful in initial sorting.

A number of the non-marine species in Europe are in decline and are considered threatened. The text of this book gives up-to-date information on the status of the species, identifies those which are threatened and the causes of their decline and thus makes a practical contribution to the future conservation of molluscs.

This book is obtainable directly from one of the authors (Dr Gerhard Falkner, Raiffeisenstrasse 5, D-8059, Worth-Horlkofen, Germany). In view of the high cost of a foreign draft on individual copies, Andrew Johnson of The Bird and Wildlife Bookshop, 2-4 Princes Arcade, Piccadilly, London SW1Y 6DS (Tel: 071-287 1407) would be able to co-ordinate orders from Britain.

JUNE CHATFIELD

THE MARGINELLIDAE (MOLLUSCA, GASTROPODA) OF PRINCIPE ISLAND (REPUBLICA DE SÃO TOMÈ E PRINCIPE)

FRANCISCO FERNANDES¹ AND EMILIO ROLÁN²

(Accepted for publication, 18th June, 1991)

Abstract: The results of collecting in Principe Island in relation to the family Marginellidae are described. Two species previously cited for Principe Island could not be found but two more and seven known from São Tomè Island are recorded. *Marginella gemma* Adams, 1850 has been rediscovered and “*Cystiscus*” *josephinae* n. sp. is formally described. The radula of some species are described for the first time. The occurrence of these species in both islands is tabulated.

Resumen: Se presentan los resultados de los muestreos realizados en la isla de Principe en relación a la familia Marginellidae: no han sido confirmadas dos de las especies mencionadas con anterioridad para la isla pero lo fueron otras dos y se encontraron siete especies más ya conocidas en la isla de São Tomè; es redescubierta *Marginella gemma* Adams, 1850 para la que se designa localidad típica; se describe *Cystiscus josephinae* n. sp.; se muestran las radulas de algunas de las especies citadas; se esquematiza en una tabla la presencia en las islas de las distintas especies.

INTRODUCTION

The Principe Island of the Republica Democràtica de São Tomè e Principe in the Guinea Gulf is actually in poor communication with the exterior and situated well away from the commercial routes. Only a small population is living there and no organized tourism exists. So, it has been rarely visited by malacologists and knowledge of its fauna is based on the explorations of the last century and very occasional visits (like the Calypso trip).

A recent revision of the family Marginellidae in São Tomè Island (Gofas & Fernandes 1988) mentions some species for Principe Island, most of them from the Navel collection (NC) in the Museum National d'Histoire Naturelle of Paris:

Marginella melvilli Tomlin & Shackleford, 1913, 1 specimen (NC)

Marginella liparozona Tomlin & Shackleford, 1913, 11 specimens (NC)

Volvarina insulana Gofas & Fernandes, 1988, 2 specimens (NC)

Persicula thomensis (Tomlin, 1918), 2 specimens (NC); Calypso, 6 specimens.

Fernandes (1987) describes other species of this family from Cape Verde Islands showing the importance of the colouration of the soft parts in specific differentiation.

The authors had the opportunity to visit Principe Island in February 1990 on a collecting trip. Among other molluscs, the family Marginellidae were collected to confirm the existence of the before-mentioned species and also to find some of the species cited for São Tomè Island by Gofas & Fernandes (1988).

¹ C.P 1038, Luanda, Republica Popular de Angola.

² C. Castillo, 22–5, 36202, Vigo, España.

RESULTS

The species found were the following:

Genus *Marginella* Lamarck, 1799

Marginella spinacia Gofas & Fernandes, 1988.

Several specimens were collected in Praia Evora, Praia Ilhame, Baia das Agulhas and Baia da Ribeira Izè. There are not so many differences from specimens of the same species from São Tomè, from where the type material originates. The animal's colour polymorphism is very similar to the specimens from São Tomè town and Santana beach, with foot, tentacles and siphon sprinkled with creamy yellow flecks and with a few rusty flecks on the siphon.

Marginella eveleighi Tomlin & Shackleford, 1913.

Numerous specimens were collected in the muddy bottom at 8–10 metres in the Baia de Santo Antonio. There are no visible differences between the specimens from here and the specimens from São Tomè, the source of the type material. The animal's colouration is similar.

The egg capsules of this species (Fig. 1) were found frequently on the turrid *Clavatula coerulea* Weinkauff which lives in the same muddy bottom.

Marginella gemma Adams, 1950 (Fig. 2).

This species is only known from the holotype (see Gofas & Fernandes 1988). From its original description, it appears to be an East African species, although erroneous localities are common in the descriptions of the last century. Hitherto there is no reference to its rediscovery in the literature.

Several specimens were collected in Praia Ilhame, Baia das Agulhas and Baia Ribeira Izè. They were half buried in sand under rocks in 1–3 metres of depth.

Description. The shells are from 11.5 mm to 13.5 mm in length with a rather high spire. Outer lip thickened with faint denticulation on the inner side. Aperture narrow, parallel-sided. Columella with 4 plaits. The body whorl carries two bands of irregular greenish flecks, one subsutural and the other basal, both separated by a clear white interspace with nearly the same width as the two bands (Fig. 2). The outer lip bears small pink blotches. Some of



Fig. 1. Egg capsule of *Marginella eveleighi* Tomlin & Shackleford, 1913, containing one developed embryo. Santo Antonio (Principe Island), in 8–10 m depth. Scale bar is 1 mm.

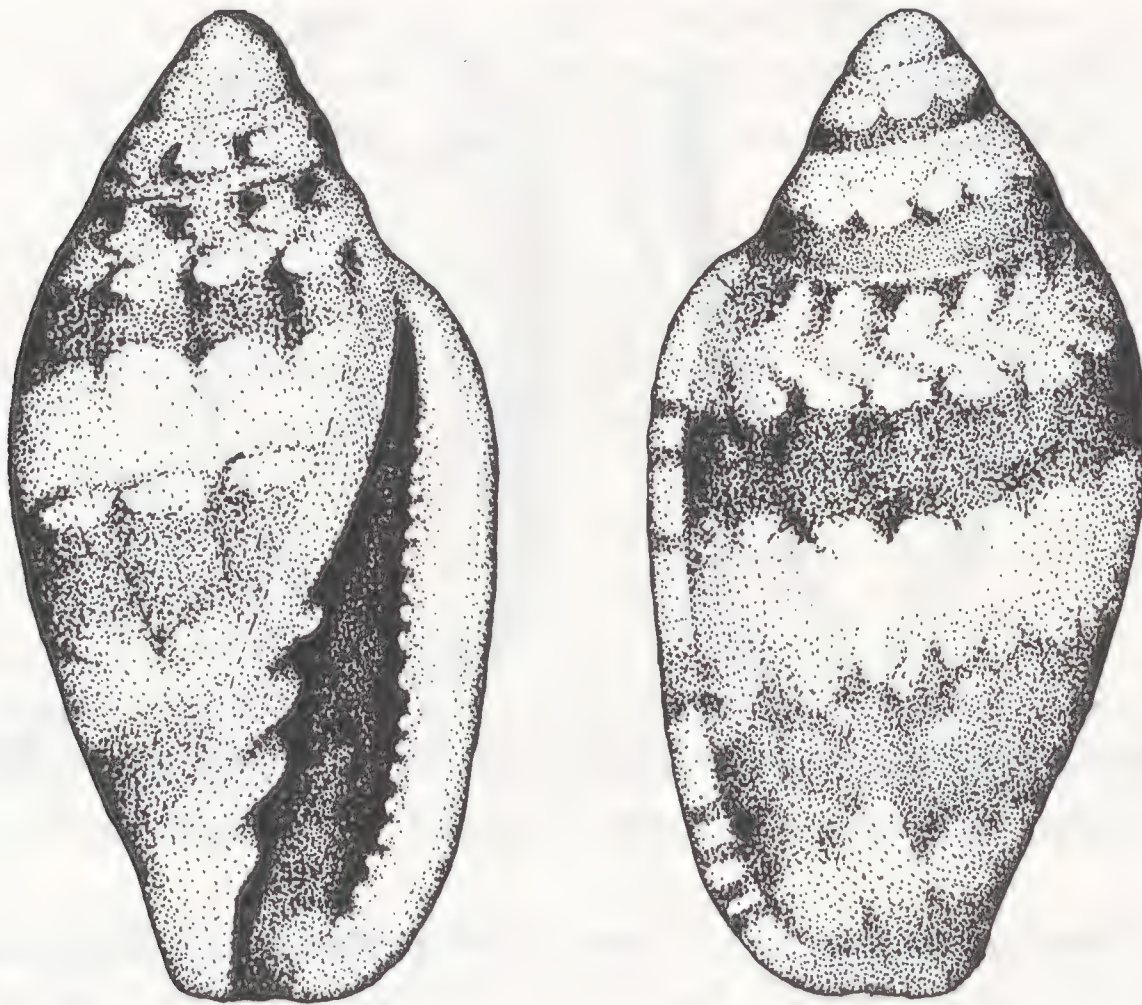


Fig. 2. *Marginella gemma* Adams, 1950. Specimen of 12.4 mm from Principe Island.

our specimens lack pigmentation on a broad band of the body whorl, like the holotype of *M. gemma*.

The animal has a translucent foot, siphon, head and tentacles, with irregular yellow flecks; in the tentacles a few of the yellow flecks are elongated as small stripes. This colouration is very different from the closely related species known from São Tomè Island: *M. melvilli* Tomlin & Shackelford, 1913 has the siphon opaque white and *M. spinacia* Gofas & Fernandes, 1988 has the body sprinkled with cream yellow and rusty flecks.

Remarks: This species, conchologically, is not very different from *Marginella melvilli* in shell pattern, however the large size, high spire and colour variation of the animal easily separate both species.

Genus *Volvarina* Hinds, 1844

Volvarina insulana Gofas & Fernandes, 1988

Several specimens were collected in Praia Ilhame, Praia Evora, Baia das Agulhas and Baia de Santo Antonio. They are not different from São Tomè specimens from the type locality. The radula of this species is shown in Pl. 1, Fig. A.

Genus *Granulina* Jousseaume, 1888

Granulina parilis Gofas & Fernandes, 1988

Several specimens were collected in Praia Evora, Praia Ilhame, Baia das Agulhas and Baia Ribeira Izè. There are no colour differences between the specimens from here and those collected in São Tomè, the source of the type material.

Genus *Cystiscus* Stimpson, 1865, *sensu* Roth and Coan (1968)

"*Cystiscus*" *gutta* Gofas & Fernandes, 1988

The genus "*Cystiscus*" is here used in the sense of Gofas & Fernandes (1988). Only three specimens were collected, in Praia Ilhame and Praia Evora. They were, in size and animal colouration, generally like the specimens from São Tomè; we noted only a small difference.

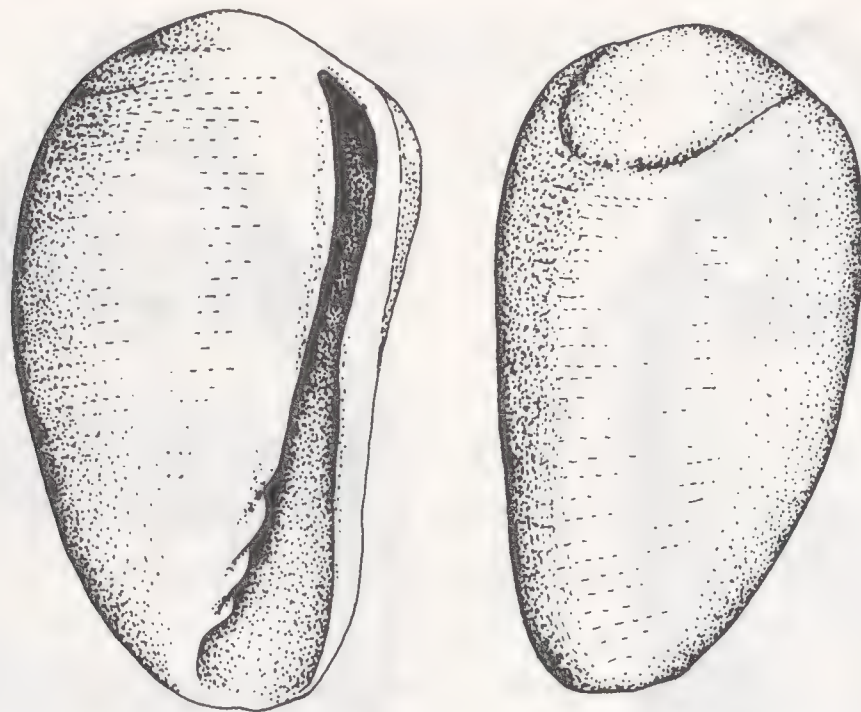


Fig. 3. Holotype of "*Cystiscus*" *josephinae* n. sp. From Praia Evora, Baia de Santo Antonio (Principe Island). Length = 2.4 mm.

The specimens from Principe Island have fewer rusty points on the siphon and anterior part of the foot.

"*Cystiscus*" *josephinae* n. sp. (Fig. 3, colour Pl. 1, Fig. C).

Etymology. Named after Maria Josephina Alvarez, who since 1987 has been a very good colleague in our researches, never complaining despite all the troubles that we had in Cape Verde, Angola, São Tomè and Principe.

Type material. Holotype (Fig. 3) length 2.4 mm collected in Praia Evora in the Baia de Santo Antonio, deposited in the Museo Nacional de Ciencias Naturales of Madrid with the number 15.05/2686. Paratypes in the collections of F. Fernandes and E. Rolán.

Description. Shell up to 2.4 mm in length, oblong, swollen posteriorly, with a low and globose spire. Outer lip thickened and curved-in, smooth internally. Columella with 3 to 4 very weak plaits, hardly exceeding one third of the anterior part. Shell material hyaline, white, showing the internal suture and soft parts.

Animal (Pl. 1, Fig. C) with internal mantle conspicuous through the shell, creamy-orange with orange dots and spots; anteriorly, close to the base and on the shoulder there are two irregular black spiral bands covered with light yellow flecks. Foot translucent, crawling flat on the substrate, with a middle white stripe at the posterior end. Tentacles are cylindrical, elongated and translucent. Siphon large, somewhat widening anteriorly coloured with dense yellow spots.

Habitat. The species was collected on rocks with dense algal mat, between 1–5 metres of water depth, together with *Granulina parilis* Gofas & Fernandes, 1988, "*Cystiscus*" *gutta* Gofas & Fernandes, 1988 and *Gibberula punctillum* Gofas & Fernandes, 1988.

Remarks. This species is congeneric, according to the shell characters, with "*Cystiscus*" *gutta*, previously known from São Tomè Islands and with which it is sympatric. However it is very easily differentiated by its smaller size and colouration of the animal. "*Cystiscus*" *gutta* has a translucent foot and a siphon covered with yellow and brown blotches and the internal mantle is dark green with a brownish median area covered with pale yellow flecks with two series of large pale yellow spots with small orange dots inside. "*Cystiscus*" *josephinae* n. sp is also congeneric with "*Cystiscus*" *bubistae* Fernandes, 1988 from the Cape Verde Archipelago

with nearly the same size and shape, but with a foot marked posteriorly by a triangular cream-yellow band, a siphon coloured with salmon-pinkish spots and the internal mantle with a cream shade marked with a few axial brown bands in the middle and basal areas.

Genus *Persicula* Schumacher, 1817

Persicula thomensis (Tomlin, 1918)

Several specimens were collected in Praia Ilhame, Praia Evora, Baia das Agulhas and Baia da Ribeira Izè. There are no differences between the specimens from here and those collected in São Tomè Island, its type locality.

Genus *Gibberula* Swainson, 1840

Gibberula modica Gofas & Fernandez, 1988.

Only two specimens were collected in Praia Evora and Praia Ilhame. Only a few flecks of green on the pale black ground of the internal mantle were seen; the rest of the animal was as the specimens known from São Tomè Island from where the type material comes.

Gibberula punctillum Gofas & Fernandes, 1988

Several specimens were collected in Praia Ilhame, Praia Evora, Baia das Agulhas and Baia da Ribeira Izè. The colouration of the animal is very variable here as are those from the São Tomè Island. The presence of specimens with pink ground colour and with few dark blotches is more frequent, but intermediate forms were found.

The radula of this species is shown in Pl. 1, Fig. B.

Gibberula cucullata Gofas & Fernandes, 1988

A single living specimen and a few other shells were collected in Praia Ilhame and Baia de Santo Antonio. There are no differences from the material collected in São Tomè (the type locality).

CONCLUSIONS

The authors could not confirm the existence of *Marginella melvilli* Tomlin & Shackleford, 1913 and *Marginella liparozona* Tomlin & Shackleford, 1913 in Principe, both discussed in Gofas & Fernandes (1988) from the Navel collection and Calypso cruise. *Marginella chalmersi* Tomlin & Shackleford, 1912 was not collected.

The presence of *Volvarina insulana* Gofas & Fernandes, 1988 and *Persicula thomensis* (Tomlin, 1918) is confirmed.

Marginella gemma Adams, 1850 has been rediscovered.

Recorded for the first time for Principe Island are the following species: *Marginella spinacia* Gofas & Fernandes, 1988, *Marginella eveleighi* Tomlin & Shackleford, 1913, "*Cystiscus*" *gutta* Gofas & Fernandes, 1988, *Granulina parilis* Gofas & Fernandes, 1988, *Gibberula modica* Gofas & Fernandes, 1988, *Gibberula punctillum* Gofas & Fernandes, 1988, *Gibberula cucullata* Gofas & Fernandes, 1988.

All the species and their distribution in both islands (São Tomè and Principe) are shown in the Table 1.

A new species is described: "*Cystiscus*" *josephinae* n. sp.

TABLE 1
Species of Marginellidae in São Tomè and Príncipe Islands

	São Tomè	Príncipe	other places
<i>Marginella spinacia</i>	+	+	
<i>Marginella melvilli</i>	+	?	
<i>Marginella liparozona</i>	+	?	
<i>Marginella chalmersi</i>	+		
<i>Marginella eveleighi</i>	+	+	Gabon
<i>Marginella gemma</i>		+	
<i>Volvarina insulana</i>	+	+	Fernando Poo
<i>Granulina parilis</i>	+	+	
" <i>Cystiscus</i> " <i>gutta</i>	+	+	
" <i>Cystiscus</i> " <i>josephinae</i>		+	
<i>Persicula thomensis</i>	+	+	
<i>Gibberula modica</i>	+	+	
<i>Gibberula punctillum</i>	+	+	
<i>Gibberula cucullata</i>	+	+	

ACKNOWLEDGEMENTS

The authors are indebted to the following persons: Maria de los Angeles Rodriguez Cobos (Cátedra de Anatomia, Santiago de Compostela) for taking the S.E.M. photographs; Serge Gofas for his opinions on several points of the text; Kathy Way of the British Museum for sending the holotype of *Marginella gemma*.

REFERENCES

FERNANDES, F., 1988. Descrizione di tre nuove specie di Marginellidae (Mollusca: Gastropoda) delle isole Capo Verde. *Argonauta*, **3** (3-4): 259-267.
GOFAS, S. & FERNANDES, F., 1988. The marginellids of São Tomè, West Africa. *J. Conch., Lond.* **33**: 1-30.

MARGINELLIDAE OF PRINCIPE ISLAND

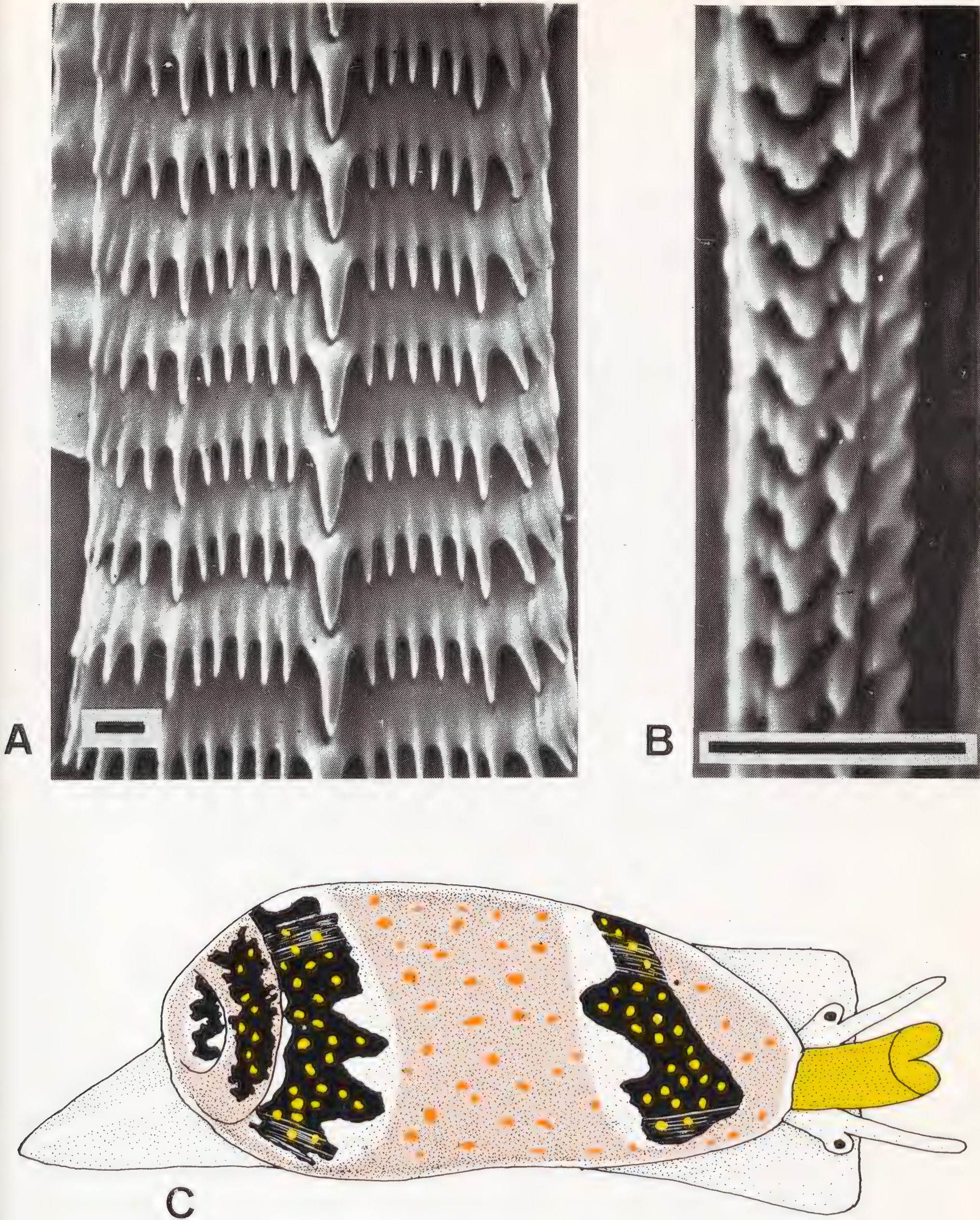


PLATE 1

- A. Radula of *Volvarina insulana* Gofas & Fernandes, 1988.
B. Radula of *Gibberula punctillum* Gofas & Fernandes, 1988 (scale bar 0,01 mm).
C. Chromatism of *Cystiscus josephinae* n. sp.

THE DISTRIBUTION OF *THEODOXUS FLUVIATILIS* (L.) IN IRELAND

J. LUCEY¹, M. L. MCGARRIGLE² AND K. J. CLABBY³

(Accepted for publication, 20th October, 1991)

Abstract: In surveys of river and stream sites in Ireland 10 per cent yielded *Theodoxus fluviatilis*. The 176 records collected since 1980 have been used to delineate the fluvial distribution: the method employed plots negative and positive loci for the species as well as abundance of sites within 10-km squares. The occurrence was tested against the solid geology, natural chemistry and size of the sites to see the relationship: 94 per cent of occurrences were from sites overlying Carboniferous strata with the bulk of these, 88 per cent, on limestone; the natural chemical characteristics of the sites from which it was recorded had the following ranges pH 7.0–8.4, alkalinity 66–304 mg/l of CaCO₃ and hardness 90–328 mg/l of CaCO₃; it was found in all river/stream size categories sampled but exhibited an apparent preference for larger sites. It was recorded from some sites with minor saline intrusion and at one location with a salinity range of at least 0.18–9.6 parts per thousand. It was found at a few sites which were classed as slightly or moderately polluted. The records from the present study were combined with the post 1950 recordings of the Conchological Society to give the overall distribution for the species in canals, lakes, rivers and streams in Ireland. Although absent from the north, including Northern Ireland, and south-west *Theodoxus* is widely spread in the country. Factors which might be important in limiting or facilitating distribution are briefly discussed.

INTRODUCTION

There is a long history of shell collecting in Ireland and reliable records exist for the nerite *Theodoxus fluviatilis* (as the synonyms *Nerita fluviatilis* and *Neritina fluviatilis*) dating back more than 170 years (e.g. Brown 1818). The known occurrence of the species was summarised by Thompson (1856) in the middle of the last century and in the early part of this century Stelfox (1911) used the vice-comital divisions to illustrate the distribution. The most recent information for the country was included in the Conchological Society's *Atlas of the non-marine Mollusca of the British Isles*, as pre and post 1950 records, recorded on the basis of a 10 km grid (Kerney 1976). It is evident that the distribution of the species has been reasonably well documented over the years and any further information merely adds to and/or updates the considerable body of data already accumulated. The objectives of the present study, as well as updating the distribution of *T. fluviatilis*, are to test some of the hypotheses regarding fluvial habitat preferences e.g. that the species is 'strictly calcicole' and 'prefers' larger rivers. *Theodoxus* is included among the freshwater molluscs considered 'vulnerable' in the U.K. i.e. believed likely to move into 'endangered' category in the near future if the environmental stress causal factors continue operating (Wells, Pyle & Collins 1983). In addition to testing its occurrence in Irish rivers in relation to the solid geology, natural chemistry and size of sites, the other factors which might have a bearing on its distribution will also be briefly discussed. The distribution data as presented will set a baseline, using regularly sampled rivers, from which any future changes might be gauged.

Environmental Research Unit, Ireland.

¹ Regional Water Laboratory, Butts Green, Kilkenny.

² Regional Water Laboratory, The Courthouse, Castlebar, Co. Mayo.

³ Pottery Road Laboratory, Kill-of-the Grange, Co. Dublin.

METHODS

The data are based on records collected since 1980 from surveys of rivers and streams in Ireland (Republic) and these are supplemented by the post 1950 recordings of the Conchological Society of Great Britain and Ireland. The authors' distribution information was obtained during surveys carried out to monitor biological water quality, usually in the summer and early autumn months when even the larger rivers are accessible, by *An Foras Forbartha* (The National Institute for Physical Planning and Construction Research) and its successor the Environmental Research Unit. Collections were made by handnet sampling using a net with a mesh of 12 threads per centimetre and initial species verification was determined using the keys and characters of Macan (1977).

The water chemistry data, reported as median values, were gleaned from Flanagan & Larkin (1986) and unpublished sources and are expressed as follows: pH as pH units, alkalinity and hardness (total) as mg/l CaCO₃. Salinity values are given as the ratio 'parts per thousand' NaCl.

The river/stream site sizes were calculated using a scheme based on distance from source in which five stages are recognised *viz.* streams, small rivers, medium rivers, large rivers and very large rivers. In the case of Irish rivers, presently available information is not sufficient to allow a size classification on the basis of flow.

The distribution data have been plotted on the 10-km squares of the Ordnance Survey National Grid and are presented in two ways: the regularly sampled river and stream sites are used to display positive and negative loci for *T. fluviatilis* within the 10-km squares with density of sites also included to indicate centres of distribution: the records from that study are combined with the 1950–1975 records of the Conchological Society (Kerney 1976) as well as 23 post 1976 recordings (Kerney *pers. comm.*) to provide an overall distribution in canals, lakes, rivers and streams throughout Ireland (with the exception of two, these records date from 1965). The Ordnance Survey grid references (each consisting of the Sub-Zone letter, a three-figure Easting coordinate and a three-figure Northing coordinate) for the authors' records are listed, together with the county and river name, annexed to the distribution map.

RESULTS

In this study a total of 1776 river and stream sites were examined of which 176 contained *Theodoxus* i.e. its presence was recorded in approximately one in ten of the locations. The sites are displayed in Fig. 1 to show positive and negative loci, as well as density, within 10-km squares. The positive loci are listed in the Annex to Fig. 1 and these records, which include 51 new 10-km square recordings, are combined with those of the Conchological Society's *non-marine census* (Kerney 1976, Kerney *pers. comm.*) to give the overall distribution in canals, lakes, rivers and streams in Ireland (Fig. 2).

The river and stream sites were classified, based on distance from source, into five size categories and the occurrence of *Theodoxus* in each was determined (Table 1). A chi-squared (χ^2) test for goodness-of-fit was applied to the data with the Null Hypothesis that the species exhibited no preference and was distributed equally among all the size categories. The expected frequency occurrence was calculated by taking into account the proportional number of times each site size category was sampled. The total χ^2 value of 184.77 at 4 degrees of freedom is highly significant at $P < 0.0001$. Therefore the results do not fit the distribution expected by the Null Hypothesis and *Theodoxus* does, from these data, show a



Fig. 1. The distribution of *Theodoxus fluviatilis* in regularly sampled rivers and streams in Ireland from records collected since 1980 and based on 10-km squares. Open circles represent the sites sampled which were negative and the solid black circles are the sites where the species has been found; the size of the circle indicates the number of sites in that square.

Cork. Awbeg: R544 186, R522 151, R543 098, R543 080, R567 083, R601 076, R657 075, R678 055, R691 005; Blackwater (Munster): W777 984, W882 987; Funshion: R738 068, R758 040, R793 030, R823 017. Tipperary. Nenagh: R915 740, R892 749, R877 780, R878 793, R874 799, R868 813, R861 822, R831 849; Suir: S396 218. Tipperary/Waterford. Suir: S144 205, S286 232. Limerick. Bunoke: R320 285; Camoge: R588 415; Daar: R301 331; Dead: R776 478; Deel: R326 285, R319 309, R353 395, R362 414, R348 418, R338 437; Groody: R637 542; Maigue: R542 328, R514 410, R481 438; Morningstar: R687 304, R665 323, R653 353, R613 367, R589 364, R559 343; Mulkear: R723 507, R697 531, R652 554, R640 583. Clare. Fergus: R270 911, R266 888, R286 886, R344 833, R330 788, R347 779. Kilkenny. Blackwater (Kilmacow): S582 155. Kilkenny/Carlow. Barrow: S683 537, S709 504, S733 458, S710 436, S726 379. Carlow. Barrow: S719 774, S698 738, S691 653, S707 626, S688 615. Carlow/Laois. Barrow: S717 802. Galway. Ahascragh: M721 404, M777 385; Ballinure: M817 270; Cloonlyon: M788 507; Island: M625 719, M662 728, M695 717; Kilcolgan: M622 179; Killian: M716 509, M740 492; Raforde: M650 291, M649 272, M610 260, M579 250, M555 238; Shannon: M980 164; Shiven: M699 492, M788 494; Springfield: M655 664. Galway/Tipperary. Shannon: M920 122. Galway/Offaly. Shannon: N002 156. Offaly. Brosna: N277 325, N233 324, N212 306, N118 242, N115 245, N047 208; Little Brosna: S079 938, S057 964, N052 035; Silver (Kilcormac): N135 187. Kildare. Barrow: N621 109, N621 094, S659 969, S682 940, S686 923; Liffey: N855 208, N875 227. Kildare/Laois. Barrow: N613 089, N632 058, N635 016, S703 882. Westmeath. Breensford: N074 442; Brosna: N337 367, N330 356, N328 352, N295 332; Inny: N392 757, N392 725, N348 648, N311 639; Shannon: N038 400, N042 391, N046 390. Westmeath/Longford. Inny: N259 603. Westmeath/Roscommon. Shannon: N050 346. Westmeath/Cavan. Inny: N403 816. Longford. Camlin: N180 795; Inny: N227 592, N183 569, N156 567, N133 560, N119 551. Longford/Roscommon. Shannon: N055 770, N073 787, N025 736, N005 693. Roscommon. Boyle: G790 019, G802 026, G816 040, G873 057, G896 037; Breedoge: M745 947; Derryhippo: M794 628; Lung: M600 922, M634 944; Suck: M671 780, M693 756, M790 649, M829 577. Roscommon/Galway. Suck: M813 531, M818 464, M843 347, M874 293, M912 259. Roscommon/Sligo. Boyle: G735 012. Mayo. Glone: M427 869, M350 918; Robe: M195 649, M180 640. Sligo. Ballysodare: G669 292; Drumcliff: G694 421; Garavogue: G713 340, G698 360; Owenmore: G642 219, G685 267; Unshin: G768 157, G740 200, G695 260, G687 270. Leitrim. Bonet: G849 339, G819 302, G794 319; Rinn: N102 897. Leitrim/Longford. Rinn: N090 865. Leitrim/Roscommon. Shannon: M974 964, N054 870, N052 863.

Fig. 1 (Annex). Records for the occurrence of *Theodoxus fluviatilis* in regularly sampled rivers and streams in Ireland, collected since 1980, listed as the Ordnance Survey grid reference (consisting of the Sub-Zone letter, a three-figure Easting coordinate and a three-figure Northing coordinate) with river and county name.

preference for larger sites. When the sites positive are shown as a percentage of the sites sampled the association with larger site size becomes apparent.

In Table 2 the occurrence of *Theodoxus* in relation to the geology and water chemistry of sites is summarised. This shows that 94% of occurrences were from sites on Carboniferous strata with the bulk of these, 88%, on limestone. Ten of the occurrences (5.7%) were from sites overlying non-Carboniferous strata and these show higher levels of dissolved 'salts' than would be expected. However all of these river sites are either influenced by limestone further upstream or have coverings of calcareous glacial drift material thus accounting for the higher water chemistry values than normally associated with such less easily weathered rock types. The distribution of Carboniferous Limestone in the country is delineated in Fig. 3 and this can be compared with Fig. 2 to establish to what extent the occurrence of *Theodoxus* corresponds. The distribution of the species corresponds with lowland areas and generally follows the Carboniferous Limestone covering except in the latter's north-easterly extension

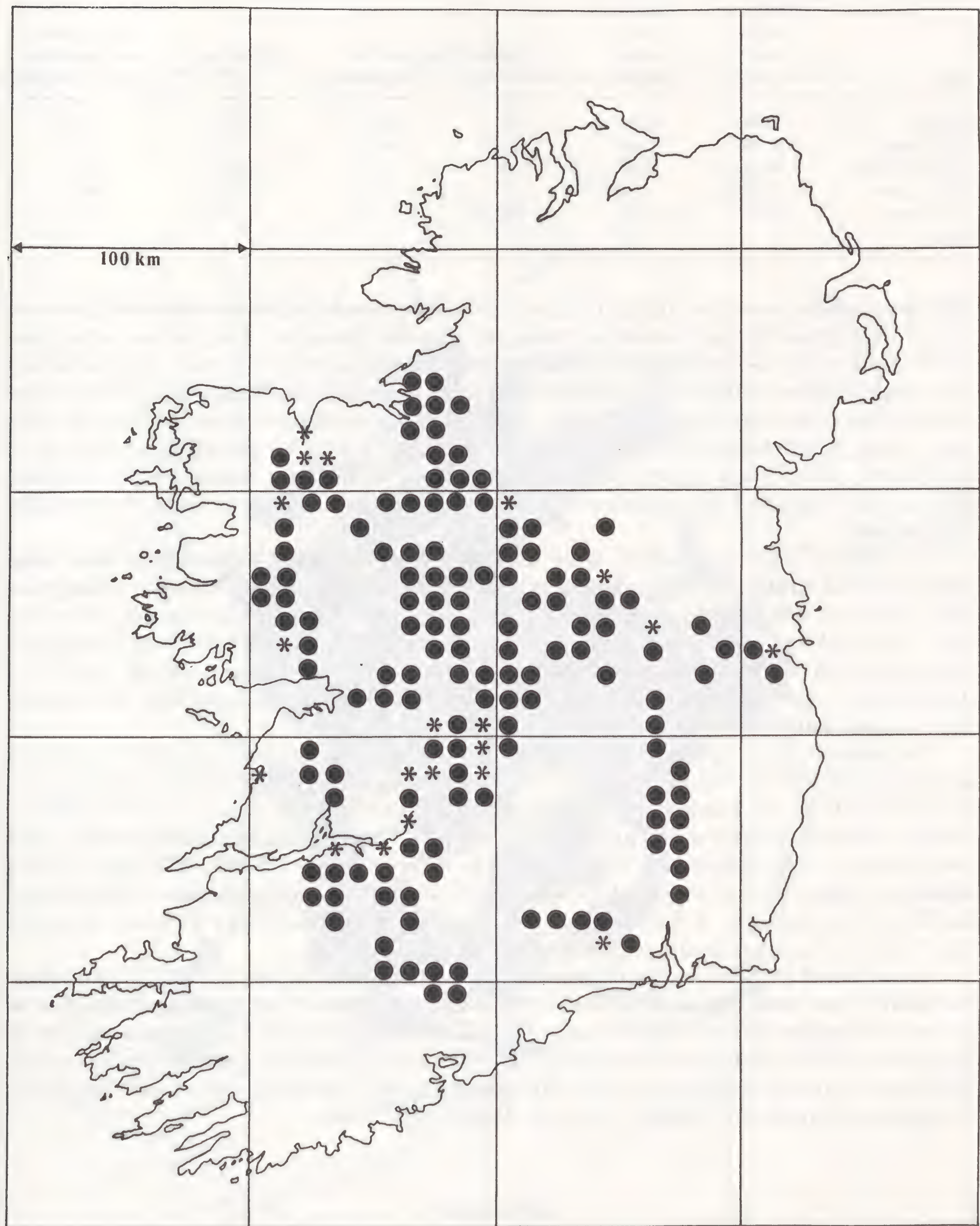


Fig. 2. Distribution of *Theodoxus fluviatilis* in Ireland based on presence in 10-km squares. The data are the records from the present study combined with the post 1950 recordings of the Conchological Society of Great Britain and Ireland (with the exception of two these date from 1965). Pre 1950 records are represented by asterisks.

TABLE 1

Occurrence of *Theodoxus fluviatilis* in relation to river/stream site size.

Type	<i>Site description</i>		<i>Number of sites positive</i>		Chi-squared (χ^2)	Sites positive as a percentage of sites sampled
	Distance from source (km)	Number of sites sampled	Observed	Expected		
Stream	0-16	1003	38	99.40	37.93	3.8
Small river	16-40	549	64	54.41	1.69	11.7
Medium river	40-80	144	38	14.27	39.46	26.4
Large river	80-130	62	25	6.14	57.93	40.3
Very large river	130+	18	11	1.78	47.76	61.1

and its peripheral outcrops. In this context it should be noted that, despite their designation, not all the Carboniferous Limestone rocks, are actually limestone. That factors other than access limit its north-easterly distribution are suggested by there being canal systems linking the upper Shannon with the Erne and thence Lough Neagh via the Blackwater. Of the larger rivers in the south-east *Theodoxus* appears conspicuous in its absence from the Nore, a hard-water river, which traverses limestone plains for a large part of its course; its absence from the Slaney, which rises in and passes through areas of intrusive bedrock type including granite and felsite and then runs over Ordovician grits and slates, is perhaps more readily understood.

In Table 3 the occurrences were divided into those on Carboniferous and non-Carboniferous strata and a chi-squared test for goodness-of-fit applied with the assumption that *Theodoxus* was equally distributed over both types. The total chi-squared value was 73.37 and tables of distribution of χ^2 show that there is a less than 0.0001% probability of obtaining such a value with one degree of freedom. Therefore the results do not fit the distribution expected ($P < 0.000001$) and sites overlying Carboniferous strata are, apparently, significantly preferred.

The sites on the regularly sampled rivers and streams from which *T. fluviatilis* specimens were recorded had the following general chemical characteristics pH 7.0-8.4, alkalinity 66-304 mg CaCO₃/l and hardness 90-328 mg CaCO₃/l. In Fig. 4 the occurrence of *T. fluviatilis* within various categories of pH, alkalinity and hardness (calculated from median values) has been plotted. This shows that 99.2% were in the pH range 7.5-8.5, 92% were in the alkalinity range 100-300 mg/l CaCO₃ and 94.4% were in the hardness range 100-300 mg/l CaCO₃. That alkalinity + hardness are related to pH in the same way is clearly shown in Fig. 4 where the figure is almost symmetrical about the centre.

It was found at some sites with minor saline intrusion and at one site (S582 155) where the salinity has been measured as 0.18-9.6 parts per thousand (‰) NaCl and can thus be classed, according to the Venice system (Perkins 1974), as ranging from freshwater to β -mesohaline. It was recorded at some locations which were affected to some degree by organic pollution e.g. five of the six sites on the River Deel where it was found were classed as slightly or moderately polluted (Clabby, Lucey & McGarrigle 1990).

DISCUSSION

Theodoxus fluviatilis has a geographical distribution extending from the Pyrenees and British Isles east to the Caucasus and from Sardinia and central Italy north to Sweden and the



Fig. 3. Distribution of Carboniferous Limestone, darkened areas, in Ireland.

TABLE 2

Percentage occurrence of *Theodoxus fluviatilis* in relation to solid geology and water chemistry (median values) of sites.

Solid geology	Occurrence	pH	Alkalinity (mg/l)	Hardness (mg/l)
Carboniferous Limestone	88.068	7.0–8.4	66–304	90–328
Avonian Shales & Sandstone	6.25	7.4–8.1	132–238	148–280
Old Red Sandstone	1.705	7.8–7.9	90–236	110–276
Ordovician Grit & Slate	0.568	8.2	226	264
Schist & Gneiss	0.568	8.0	172	194
Pre-Cainozoic Basalt	0.568	7.9	190	200
Rhyolite	0.568	8.2	206	222
Granite & Felsite	1.705	8.1–8.2	203–236	233–277

TABLE 3

Occurrence of *Theodoxus fluviatilis* at sites on Carboniferous and non-Carboniferous strata.

Stratum	Number of sites sampled	Number of sites positive		Chi-squared* (χ^2)	Sites positive as a percentage of sites sampled
		Observed	Expected		
Carboniferous	1122	166	111.19	27.02	14.8
Non-Carboniferous	654	10	64.81	46.35	1.5

* Yates' correction has not been applied in calculating chi-squared values despite there being just one degree of freedom. If applied the new values of chi-squared would be 26.53 and 45.51 respectively.

coasts of Finland (Fretter & Graham 1978). In Britain it is apparently absent from Devon and Cornwall in England and occurs only in Glamorgan in Wales and Orkney in Scotland. In Ireland, as shown in the present study, it is absent from the south-west and most of Ulster including Northern Ireland. In terms of European distribution the Irish populations of *Theodoxus* include the most westerly. It has been regarded as absent from Ulster (e.g. Stelfox 1911, Praeger 1950) but was recorded from Lough Sheelin (County Cavan) in that province by Macan & Lund (1954), who were apparently unaware of the significance, and in the present study in the River Inny at Finnea on the Cavan-Westmeath boundary. It is however apparently absent from almost all of the province including Northern Ireland.

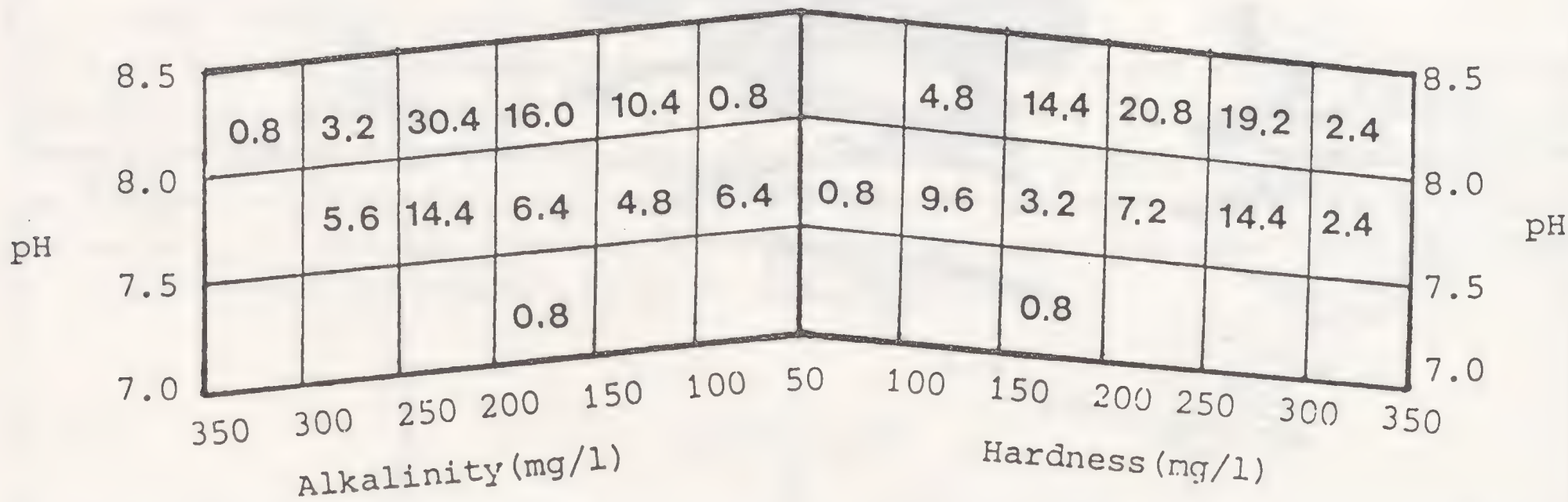


Fig. 4. Percentage occurrence of *Theodoxus fluviatilis* within various categories of pH, alkalinity and hardness (both as CaCO₃).

The distribution pattern of *T. fluviatilis* in Ireland can be compared to that of another aquatic invertebrate, the crayfish *Austropotamobius pallipes* (Lucey & McGarrigle 1987), which is also classed as calicicole, except that the former has a mid-westerly range while the latter shows a more northerly range particularly in its north-easterly diffusion. However in this regard it is of interest to note that there are references in 18th and 19th century literature of movement, by human agency, of crayfish from southern districts to the north of the country for stocking. Approximately 44% of the rivers and 19% of the sites containing *T. fluviatilis* also harboured *A. pallipes*.

Theodoxus does not occur further north, roughly, than a line joining the mouths of the rivers Boyne and Erne. Stelfox (1911) remarked that its absence from the Fermanagh lakes was worthy of special notice but it is also worth noting that these occupy basins which though classed as Carboniferous Limestone are, for the most part, carved from the less resistant shales and 'Calp' limestones of the Lower Carboniferous (Whittow 1975). Temperature may also exert some influence in limiting its northerly extension. It is known that the severe winter of 1935 caused the deaths of large numbers in the Lough of Harray in Orkney (Tomlinson 1936), the less saline of the two stations for the species in Scotland. The northern limit of *T. fluviatilis* in Ireland appears therefore to coincide with what could be loosely defined as the northern limit of what are known as the Central Lowlands.

Macan (1977) has remarked that *Theodoxus* resembles a marine rather than a freshwater species in appearance—which given the origin of the freshwater prosobranchs is not altogether surprising—and as already noted above has been found during the present study at one location with a salinity range of at least 0.18–9.6‰. It has been found in salinities of 0 to 7‰ in rock-pools of the island of Bornholm (Denmark) in the Baltic by Johnsen (1946) who quoted Johansen (1918) that it could endure up to 15‰ salinity; on the North Sea coast of the mainland it has also been collected, from the inlet at Ringkøbing, where salinity was measured as ranging between 8.9 and 11.1‰ (Lumbye 1958). Scharff (1896) was aware that it lived—together with other essentially freshwater fauna—in the Baltic alongside marine species and drew on the information to advance his theories regarding the origin of the European fauna. It has, however, been known from the brackish-water lochs, Harray and Stenness, of Orkney (Boycott 1936a, Nicol 1938) for some time where the salinity in the latter was as high as 17‰.

T. fluviatilis appears to be unimportant as a food item for trout (*Salmo trutta*) which are ubiquitous in the rivers covered in the present study and the predatory impact from that source must be insignificant; a single specimen has been recorded by Kennedy & Fitzmaurice (1971) among the stomach contents of a trout in the River Fergus. Similarly eels (*Anguilla anguilla*) are plentiful in these waters and although occasionally found in gut analyses, *Theodoxus* is apparently not important in the diet of that fish either (Moriarty *pers. comm.*).

As already mentioned, *Theodoxus* is listed among the freshwater molluscs deemed vulnerable in Britain, by the International Union for Conservation of Nature and Natural Resources, and accordingly could become endangered in the near future if factors such as pollution and habitat disruption continued to operate. It is, however, included among the macroinvertebrate species regarded as tolerant of moderate organic enrichment (Hellawell 1986) and receives a rating of 6, from the range 1–10, in the score system used for monitoring biological water quality in England and Wales (National Water Council 1981). Its presence in the eutrophic River Deel in the present study, where excessive growths of algae and macrophytes are reflected in the dissolved oxygen supersaturation and raised pH values recorded (Lennox & Toner 1980), would seem to support it being regarded as a species which can withstand some degree of organic enrichment. The channel length of the regularly sampled rivers and streams considered in the present study had the following profile regarding pollution: 84% unpolluted, 9% slightly polluted, 5% moderately polluted and 2%

seriously polluted (Water Pollution Advisory Council 1983). The relatively low proportion of serious pollution doubtless facilitates the widespread distribution of *T. fluviatilis* in suitable habitats in the country.

The results in the present study are generally in agreement with the fluvial habitat preferences of *T. fluviatilis* given by other workers e.g. that it is strictly a calcicole species in Ireland (Stelfox 1911, Kerney 1972); that it is found in small and large calcareous rivers (Boycott 1936b, Macan 1977); that larger/lowland rivers are among its chief habitats (Stelfox 1911, Kerney 1973). Eighty years ago it was observed that the stations for the species then known all lay on Carboniferous Limestone (Stelfox 1911). The results presented here show that 21 of the river sites were on other rock types but 11 of these were also Carboniferous strata (Avonian shales and sandstones) and the 10 non-Carboniferous locations were either influenced by the river having travelled over limestone further upstream or had coverings of calcareous drift (glacial) material. Kennedy & Fitzmaurice (1971) observed that in Irish rivers hard-water snails, such as *Theodoxus*, do not become abundant, or in some cases even occur, until the bicarbonate alkalinity is upwards of 2.5 meq/l (i.e. 125 mg/l CaCO_3); in natural waters when pH is less than 8.3 the bicarbonate alkalinity represents the total alkalinity. In the present study, where the results for chemical analyses are based on median values, 92.8% of occurrences were greater than 100 mg/l CaCO_3 alkalinity while 99.2% were greater than 100 mg/l CaCO_3 hardness (Fig. 4).

The present study increases the 10-km square post 1950 records (to January 1990) of the Conchological Society for *Theodoxus* from 86 (Kerney 1976, Kerney *pers. comm.*) to 137. It was recorded from 93 of the 522 10-kilometre squares sampled and it is interesting to note that this is exactly the same proportion recorded by a party of members of the Conchological Society on an excursion to Ireland in 1972 when it was present at 19 of the 107 squares examined (Kerney 1973). From the data presented here (see Fig. 2) it can be seen that twenty pre 1950 10-km square records have not been updated by the latest study. One-half of these were not surveyed by the authors, who did not include lakes and canals in their study, while sites in the other ten squares were sampled but did not yield *Theodoxus*. Some of the older records are ambiguous with regard to specific location but two rivers can positively be identified as no longer supporting the species and in the case of one of these the extinction is attributed to pollution. The aspect of changes with time will be investigated further by a comparative analysis of the known vice-comital distribution for the species up to 1911 with that of some eighty years later (Lucey *in prep.*).

The authors' believe that the occurrence of *T. fluviatilis*, particularly with regard to rivers, in Ireland has been adequately established and that the work, because of the manner in which it is presented, will serve as a baseline from which any future changes might be gauged.

REFERENCES

- BOYCOTT, A. E., 1936a. *Neritina fluviatilis* in Orkney. *J. Conch., Lond.* **20**: 199–200.
 —, 1936b. The habitats of fresh-water Mollusca in Britain. *J. Anim. Ecol.* **5**: 116–186.
 BROWN, T., 1818. Account of the Irish Testacea. *Mem. Wernerian Nat. Hist. Soc.* **2**: 501–536.
 CLABBY, K. J., LUCEY, J. & MCGARRIGLE, M. L., 1990. *Interim Report on the Biological Survey of River Quality. Results of the 1989 investigations*. Environmental Research Unit, Dublin.
 FLANAGAN, P. J. & LARKIN, P. M., (eds.), 1986. *Water Quality in Ireland. The Current Position. Part Two: River Quality Data*. An Foras Forbartha, Dublin.
 FRETTER, V. & GRAHAM, A., 1978. The prosobranch molluscs of Britain and Denmark. Part 3 – Neritacea, Viviparacea, Valvatacea, terrestrial and freshwater Littorinacea and Rissoacea. *J. Moll. Stud. (Suppl.)* **5**: 100–152.
 HELLAWELL, J. M., 1986. *Biological Indicators of Freshwater Pollution and Environmental Management*. Elsevier, London.

LUCEY ET AL.: THE DISTRIBUTION OF *THEODOXUS FLUVIATILIS* (L.) IN IRELAND

- JOHANSEN, A. C., 1918. *Randers Fjords Naturhist.* Kobenhavn.
- JOHNSEN, P., 1946. The rock-pools of Bornholm and their fauna. *Vidensk. Medd. fra Dansk naturh. Foren.* **109**: 1–53.
- KENNEDY, M. & FITZMAURICE, P., 1971. Growth and food of brown trout *Salmo trutta* (L.) in Irish waters. *Proc. R. Ir. Acad.* **71B**: 269–352.
- KERNEY, M. P., 1972. Mapping non-marine Mollusca in south-west Ireland, summer 1971. *Ir. Nat. J.* **17**: 182–185.
- , 1973. Mapping non-marine Mollusca in north-west Ireland, summer 1972. *Ir. Nat. J.* **17**: 310–316.
- , (ed.) 1976. *Atlas of the non-marine Mollusca of the British Isles*. Institute of Terrestrial Ecology, Cambridge.
- LENNOX, L. J. & TONER, P. F., 1980. *The National Survey of Irish Rivers. A Third Report on Water Quality*. An Foras Forbartha, Dublin.
- LUCEY, J. & MCGARRIGLE, M. L., 1987. The distribution of the crayfish *Austropotamobius pallipes* (Lereboullet) in Ireland. *Ir. Fish. Invest.* **A**, 29.
- LUMBYE, J., 1958. The oxygen consumption of *Theodoxus fluviatilis* (L.) and *Potamopyrgus jenkinsi* (Smith) in brackish and fresh water. *Hydrobiologia*, **10**: 245–262.
- MACAN, T. T., 1977. A key to the British fresh- and brackish-water gastropods. *Scient. Publs. Freshwat. biol. Ass.* **13**: 1–44.
- MACAN, T. T. & LUND, J. W. G., 1954. Records from some Irish lakes. *Proc. R. Ir. Acad.* **56B**: 135–157.
- NATIONAL WATER COUNCIL, 1981. *River Quality: the 1980 survey and future outlook*. National Water Council, London.
- NICOL, E. A. T., 1938. The brackish-water lochs of Orkney. *Proc. R. Soc. Edin.* **58**: 181–191.
- PERKINS, E. J., 1974. *The Biology of Estuaries and Coastal Waters*. Academic Press, London.
- PRAEGER, R. L., 1950. *Natural History of Ireland*. Collins, London.
- SCHARFF, R. F., 1896. On the origin of the european fauna. *Proc. R. Ir. Acad.* **4**: 427–514.
- STELFOX, A. W., 1911. A list of the land and freshwater mollusks of Ireland. *Proc. R. Ir. Acad.* **29B**: 65–165.
- THOMPSON, W., 1856. *The Natural History of Ireland*. Vol. 4. Bohn, London.
- TOMLINSON, J. R. LE B., 1936. Mollusca destroyed by frost. *J. Conch., Lond.* **20**: 273–274.
- WATER POLLUTION ADVISORY COUNCIL, 1983. *A Review of Water Pollution in Ireland. A Report to the Council by An Foras Forbartha*. Water Pollution Advisory Council, Dublin.
- WELLS, S. M., PYLE, R. M. & COLLINS, N. M., 1983. *The IUCN Invertebrate Red Data Book*. International Union for Conservation of Nature and Natural Resources, Gland and Cambridge.
- WHITTOW, J. B., 1975. *Geology and Scenery in Ireland*. Penguin Books, Harmondsworth.

NOTES ON NAIAD TAXONOMY (BIVALVIA:UNIONOIDA)

2. THE GENUS *PRISODONTOPSIS* TOMLIN, 1928

FRED R. WOODWARD¹

(Accepted for publication, 20th October, 1991)

Abstract: The taxonomic status of the African freshwater bivalve '*Unio johnstoni* Smith' (non *Unio johnstoni* Etheridge, 1881) belonging to the genus *Prisodontopsis* Tomlin, 1928 is reviewed. A lectotype is selected and a new replacement name (*Prisodontopsis aviculaeformis*) proposed. The subfamily Dentaspatharinae Modell, 1964 (a replacement name for Pseudaviculinae Modell, 1942) is restricted to fossil species belonging to *Dentaspatharia*. The subfamily Prisodontopsinae Pain & Woodward, 1968 should be retained for the Recent genus *Prisodontopsis* Tomlin, 1928.

It would be difficult to equal the tangled nomenclature maze traversed by the shell described and figured by E. A. Smith (1893, p. 640 Pl. LIX figs. 18–20) as *Unio (Metaptera) johnstoni*, a freshwater mussel belonging to the Superfamily Unionoidea. It was collected by Mr. R. Crawshaw from Lake Mweru, Central Africa and presented to the British Museum (Natural History), London, by H. H. Johnston Esq. C.B., HM Commissioner in British Central Africa and named in his honour. Due to its striking resemblance to the marine genus *Avicula* it was placed into a distinct genus of its own, *Pseudavicula* by C. T. Simpson (1900, p. 860). However, as J. R. le B. Tomlin (1928, p. 66), pointed out, *Pseudavicula* Simpson, 1900 is pre-occupied by *Pseudavicula* (Etheridge ms.) Hudleston (1890, p. 244), type species *Lucina anomala* Moore, (1870, p. 251 Pl. 14 Fig. 4), a Lower Cretaceous bivalve from Australia. Hudleston's genus is placed in the Family Oxytomidae Ichikawa (1958, p. 158), belonging to the Superfamily Pectinoidea Rafinesque, (1815, p. 148). In addition Tomlin (1928, p. 66), proposed the genus *Prisodontopsis* to replace *Pseudavicula* Simpson, with *Unio (Metaptera) johnstoni* Smith as type species.

Subsequently Modell, (1942, p. 176), proposed the erection of a distinct subfamily Pseudaviculinae based upon shell characters to contain the single species *Pseudavicula johnstoni* (Smith) apparently being unaware of the invalidity of Simpson's genus. Modell considered his new subfamily to belong to the Family Mutelidae Gray, (1847, p. 197), = Iridininae Swainson, (1840, p. 261).

In the third version of his Natural System of the Naiades Modell (1964, p. 83), erected a new subfamily Dentaspatharinae together with its type genus *Dentaspatharia*, the new subfamily to also incorporate his subfamily Pseudaviculinae as well as Iridinae Modell, (1942, p. 176), in part.

Independently Pain & Woodward (1968, p. 191), proposed the subfamily Prisodontopsinae as a replacement for Pseudaviculinae Modell, 1942 with *Prisodontopsis* Tomlin 1928 as type genus, at the same time removing it from the Mutelidae to the Unionidae. Their reasons for separating it from other African unionids and mutelids was based upon a combination of its distinctive shell features and anatomy.

Modell's Dentaspatharinae is based entirely upon shell characters of a fossil species with the result that its anatomical relationships to the Recent genus *Prisodontopsis* are pure speculation. For this reason the replacement in 1964 of his 1942 subfamily Pseudaviculinae

¹ Art Gallery & Museum, Kelvingrove, Glasgow G3 8AG.

by the new subfamily Dentaspatharinae would seem questionable. It is proposed herewith that Dentaspatharinae Modell, 1964 should be restricted to contain the fossil species belonging to *Dentaspatharia* Modell, 1964, type species *Unio galloprovincialis* Matheron, (1842, p. 168), and replacing Pseudaviculinae Modell, 1942 by Prisodontopsinae Pain & Woodward, 1968 for the Recent genus *Prisodontopsis* Tomlin, 1928 since *Prisodontopsis* is the next available generic name for *Pseudavicula* Simpson, 1900.

In this connection it should also be pointed out that the subfamily Prisodontopsinae Pain & Woodward was inadvertently misspelt by them (1968, p. 206), as well as in the Zoological Record (1968, p. 151) as Prisodonopsinae.

Finally the type species of *Prisodontopsis* Tomlin 1927, namely *Unio (Metaptera) johnstoni* Smith, 1893, also proves to be invalid since it is pre-occupied by *Unio johnstoni* Etheridge, (1881, p. 20 Figs. 1, 2), which was proposed for an Australian Tertiary freshwater mussel. McMichael (1957, p. 227) described his new genus *Prohyria* with *Unio johnstoni* Etheridge as type species.

The Recent African freshwater mussel *Prisodontopsis johnstoni* (Smith, 1893) is thus without a valid name and it is herewith proposed that *Prisodontopsis aviculaeformis*, nom. nov., should be substituted in its place.

As a result of this action the syntypes of *Unio (Metaptera) johnstoni* Smith become the types of *Prisodontopsis aviculaeformis* nomen novum pro *Prisodontopsis johnstoni* (Smith).

This type material is in the British Museum (Natural History) in London and consists of two examples registration numbers BMNH 93-8-23-100/1. The label states –

Unio (Metaptera) johnstoni Smith Type. Lake Mweru, Central Africa H. H. Johnston Esq.

In addition the base of the box is inscribed –

Unio (Metaptera) johnstoni Smith. Lake Mweru (Crawshay) PZS 1893 93-8-23-100-1

The largest shell proves to be the shell figured by Smith in the *Proceedings of the Zoological Society of London* on plate LIX figures 18, 19, and 20. Since Smith did not designate a holotype it must be considered a syntype and is herewith selected as lectotype of *Prisodontopsis johnstoni* (Smith), = *Prisodontopsis aviculaeformis*, mihi, the second example becoming a paralectotype.

Dimensions (in mm):

	Length	Height/umbo	Max./height	Thickness
Lectotype	51.7	20.85	30.5	9.2
Paralectotype	37.9	15.0	24.15	5.7

The revised taxonomy is as follows:

- Order UNIONOIDA (Stoliczka, 1871) Weir 1969, p. N 401
nom. corr. pro Order UNIONACEA Stoliczka, 1871
- Superfamily UNIONOIDEA (Fleming, 1828) Thiele, 1935, p. 815
- Family UNIONIDAE Fleming, 1828, p. 415
- Subfamily PRISODONTOPSINAE Pain & Woodward, 1968, p. 195
substitute for PSEUDAVICULINAE Modell, 1942, p. 176
(= DENTASPATHARINAE Modell, 1964 in part, p. 83)
type genus *Pseudavicula* Simpson, 1900, p. 861
(non *Pseudavicula* Jack & Etheridge, 1892, p. 449)
name changed to *Prisodontopsis* Tomlin, 1928, p. 66
type species *Unio (Metaptera) johnstoni* Smith, 1893, p. 640

WOODWARD: NOTES ON NAIAD TAXONOMY

(non *Unio johnstoni* Etheridge, 1881, p. 20)

name changed to *Prisodontopsis aviculaeformis* nom. nov.

The species is described in detail, including its anatomy, by Pain & Woodward (1968, pp. 206–212) under *Prisodontopsis johnstoni* (Smith) and its distribution is Lake Mweru and the Luapula River, Central Africa.

ACKNOWLEDGEMENTS

I would like to place on record my sincere thanks to the staff of the Mollusca Section, British Museum (Natural History) for their invaluable help and allowing me access to Smith's types, to Gina Douglas and the Linnean Society for the use of library facilities and to my colleagues at Glasgow for comments and advice during the preparation of the various drafts of the manuscript.

REFERENCES

- ETHERIDGE, R., 1881. *Pap. Proc. R. Soc. Tasm.* 1880: 20 figs.
- FLEMING, J., 1828. *History of British Animals*: i–xxiii, 1–565. Bell & Bradfute, Edinburgh.
- GRAY, J. E., 1847. A list of the Genera of Recent Mollusca, their synonyma and types. *Proc. zool. Soc. Lond.*, **15**: 129–219.
- HAAS, F., 1969. Superfamilia Unionacea. *Das Tierreich*, **88**: 1–X, 1–663.
- HUDLESTON, W. H., 1890. Further notes on some Mollusca from West Australia. *Geol. Mag.*, **7**: 241–246, pl. ix.
- ICHIKAWA, K., 1958. Zur Taxonomie und Phylogenie der triadischen "Pteridae" (Lamellibranch) – mit besonderer Berücksichtigung der Gattungen *Clairia*, *Eurmorphotis*, *Oxytoma* und *Monotis*. *Palaeontographica A*, **111**: 131–212 text figs + 4 pls.
- JACK, R. L. & ETHERIDGE, R., 1892. *The Geology and Palaeontology of Queensland and New Guinea*. Text & Atlas, 2 vols.: xxx, 1–768, 68 Pls.
- McMICHAEL, D. F., 1957. A review of the fossil freshwater Mussels of Australia. *Proc. Linn. Soc. N. S. W.*, **81** (3): 222–244 Pls. XIII & XIV, one text figure.
- MATHERON, P. P. E., 1842–43. Catalogue Méthodique et descriptif des Corps organisés fossiles du département des Bouches-du-Rhône et lieux circonvoisins; précédé d'un Mémoire sur les terrains supérieurs au Grès Bigarré du S. E. de la France. *Rép. trav. Soc. Stat. Marseille*, **6**: 1–269, 41 Pls.
- MODELL, H., 1942. Das Natürliche System der Najaden. *Arch. Molluskenk.*, **74** (5/6): 161–191.
- , 1964. Das Natürliche System der Najaden 3. *Arch. Molluskenk.*, **93** (3/4): 71–126
- MOORE, C., 1870. Australian Mesozoic Geology and Palaeontology. *Q. Jl. geol. Soc. Lond.*, **26**: 226–261, pls.
- PAIN T. & WOODWARD, F. R., 1968. A Monograph of the African bivalves of the genera *Brazzaea* Bourguignat, *Mweruella* Haas, *Prisodontopsis* Tomlin and *Pseudospatha* Simpson. *Rev. Zool. Bot. afr.*, **77** (1–2) 190–220 Pls. 3–4.
- RAFINESQUE, C. S., 1815. *Analyse de la Nature*.
- SIMPSON, C. T., 1900. Synopsis of the Naiades. *Proc. U.S. natn. Mus.*, **22**: 501–1044, pl.
- SMITH, E. A., 1893. On a Collection of Land and Freshwater Shells transmitted by Mr. H. H. Johnston, C. B., from British Central Africa. *Proc. zool. Soc. Lond.*: 632–6 pl. 59.
- SWAINSON, W., 1840. *A Treatise on Malacology*. Longman, Orme, Brown, Green & Longmans, London: 1–419.
- THIELE, J., 1935. *Handbuch der systematischen Weichtierkunde*. Part 2. Gustav Fischer, Jena.: 779–1154 + 114 text figs.
- TOMLIN, J. R. LE B., 1928. Pseudavicula Simpson preoccupied. *Nautilus. Philad.*, **42**: 66.
- Zoolological Record* 1968, vol 105A (Pt. 9): Mollusca: 1–165.

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND PROCEEDINGS

REPORT OF THE COUNCIL 1989–1991

It is with regret that the Society has to announce the deaths of the following members: Mr. W. G. Buick, a member since 1972, Dr. L. Forcart who joined the Society in 1930, Mr. W. Karo a member since 1962, Mrs H. Boswell, a life member since 1952 and Mr. M. Glauser who joined in 1984.

We apologise for publishing erroneous information. At the A.G.M. on 17th March 1990 it was announced that Dr. W. S. S. van der Feen had died and this information was subsequently published in the *Journal of Conchology*, Volume **33**, part 6. We are glad to announce that Dr. van der Feen is alive and living in a Senior Citizens Home. She joined the Society in 1924 and is now aged 92 yrs. She donated her extensive library to the Amsterdam University Museum and cancelled all personal subscriptions to scientific journals. We are indebted to Dr. H. E. Coomans for the above information and apologise for any embarrassment which may have arisen.

Membership

The total membership now stands at 460 and includes the following categories: Full members, Family members, Student and Junior members, 34 Life members, 8 Honorary members and 40 Institutional members. In addition there are 140 Subscribers.

New Members

March 1989 – February 1990: 10 Full members, 3 Family members, 1 Junior member and 2 Institutional members.
March 1990 – February 1991: 13 Full members.

Resignations

March 1989–February 1991: 38.

The membership figures cover the period March 1989–February 1991 as no membership data was available for the 1989–1990 period.

Meetings for 1989–1991

There were seven Ordinary meetings and the Annual General Meeting held in the Demonstration Room of the Natural History Museum in 1989 and 1990. A Special General Meeting was held on 21st October 1989 and an Emergency Special General Meeting on 17th November 1990. A joint meeting was held with the Linnean Society at Burlington House, Piccadilly on the 1st November 1990. A Marine Workshop was held at Mrs. J. Light's house in Godalming, Surrey in 1989 and 1990.

Publications 1989–1990

Four parts of the *Journal of Conchology* were issued (Vol 33 parts 3, 4, 5 and 6.) Eight issues of

the *Conchologists' Newsletter* were issued and the Annual Programme Card of events for 1990 and 1991. A full list of members was also issued in September 1990. One Paper for Students (No. 20) on Marine Aquaria has been issued. "*The Distribution of the Marine Molluscs of North West Europe*" by D. R. Seaward was published by The Nature Conservancy Council in collaboration with the Conchological Society in December 1990. The Society is very grateful to N.C.C. for the publication of this very important marine work, which 'up-dates' the "*Sea Atlas of Marine Molluscs of Britain and Ireland*" by D. R. Seaward, published by N.C.C. in 1982. We are very grateful to Imperial Chemical Industries Charity Trust for a grant towards the cost of collecting and collating data. This latest publication includes many new records and much historic data from an extensive literature search. It also greatly extends the sea area covered in the 1982 publication. The whole of the North Sea and shorelines from Bergen to Brest are included as well as the deep water in the eastern Atlantic. Modern nomenclature is also incorporated.

Change of Honorary Secretary

In March 1990 Dr. M. B. Seddon resigned from the post of Honorary Secretary. In April 1990 the Council appointed Mrs. E. B. Rands as 'Acting' Honorary Secretary to deal with the affairs of the Society during the summer of 1990. As no one was forthcoming to fill the vacancy Mrs. Rands agreed to continue until the Annual General Meeting on 16th March 1991. Council are pleased to announce that the books are in 'good order' and apologise for any problems which have arisen during a very difficult period.

Change of Honorary Editor of the Journal of Conchology

Dr. B. F. Coles is retiring from the post of Hon. Editor and Council would like to express gratitude to him for the excellent service he has given to the Society in maintaining a very high standard in the Journal.

Change of Honorary Marine Recorder

Mr. D. R. Seaward is retiring from the post of Marine Recorder. He must be congratulated for the excellence of his work during his term in office. He has brought a calmness to the marine scene which was much appreciated by his colleagues. He must also be congratulated for the publication of "*The Sea Atlas of Marine Molluscs of Britain & Ireland*", 1982 and "*The Distribution of Marine Molluscs of North West Europe*", 1990 in conjunction with N.C.C. We are pleased to announce that he will continue to have close association with the Council and will deal with all matters arising out of the latter publication.

E. BERYL RANDS
'Acting' Honorary Secretary.

Programme Secretary's Report

Seven ordinary indoor meetings and one annual general meeting were held at the BM(NH) during 1990. The Society is grateful to the following speakers: Dr D. T. Holyoak, Mr P. Jamieson, Dr M. B. Seddon, Dr D. G. Reid and Mrs H. Ross. The April meeting was held jointly with the Tertiary Research Group at which talks were given by Mr S. Tracey, Dr A. J. Rundle, Dr P. E. Long and Mr J. Cooper.

In November a joint meeting was hosted by the Linnean Society of London at Burlington House, Piccadilly on the subject of Molluscan Biogeography. Papers were given by Dr B. Colville, Mr D. R. Seaward, Mrs J. M. Light, Mr I. J. Killeen, Dr J. D. Nunn, Dr R. C. Preece, Prof. E. Gittenberger, Dr C. R. C. Paul, Dr M. B. Seddon, and Mr F. Woodward. This provided an opportunity for the Society to promote its biological recording activities and was a particularly successful and well attended meeting.

PROCEEDINGS

1990 has seen a continuation of the revival of interest in field meetings with attendances averaging 13 participants. Nine were held to the following localities: Sheppey, Kent (joint meeting with Tertiary Research Group); Oulton Broad, Suffolk; Camber, Sussex; Weymouth, Dorset; the Mendips; Timberland Delph, Lincs; Gower, S. Wales; Uffton Fields, Warks; Anglesey (joint meeting with Porcupine). Thanks are due to the leaders of these meetings: Dr J. Cooper, Mr I. J. Killeen, Mr J. L. Jones, Mr C. P. Palmer, Mrs S. Davies, Mr J. Redshaw, Mr A. Seccombe, Mr J. Brown and Dr I. Rees.

The sixth British marine workshop was hosted by Mrs J. M. Light in Godalming, Surrey to whom the Society extends its thanks: also to Mr J. E. Phorson and Mr I. J. Killeen for tuition.

REPORT OF THE TREASURER FOR THE YEAR ENDED 31 DECEMBER 1990

The accounts show a profit of £84.45 after transfers to reserves as compared to a loss of £1,615.00 for the previous period.

The excess of income over expenditure was £2,055.47 compared with a deficit of £2,478.81 for 1989. This change is principally due to the increase in revenue from subscribers due to the increase in subscription rate and the fall in publication costs. The fall in publication costs is due to the absence this year of coloured plates in the *Journal*. After taking into account the colour plates the underlying trend in publication costs is however an increasing one.

The increase in postage and stationery costs is due to the rise in postage rates and also last years newsletter postage was included in publication costs. Newsletter postage costs have been separated out this year and thus partly accounts for what appears to be 100% increase in postage and stationery costs.

Despite the increase in subscription rates the income from ordinary members fell slightly due to a high level of resignations and payments at the old rate. All members who underpaid in 1990 have been written to in order to make good the deficit.

Investment income increased slightly due to increased interest on the Post Office Savings Bond and an increased dividend from the M&G Unit Trust. The Post Office Savings Bank interest includes an element from 1989 as a result of an under estimate in the 1989 accounts.

The apparent fall in income from Deeds of covenant is a result of the 1989 figure including amounts which relate to 1988.

Council gave permission for a publicity reserve to be set up, the purpose of this reserve is for the funding of publicity material which will include 'inter alia' a new Society brochure, stationery, exhibition boards and other literature.

The Society's cash position at the year end was acceptable however it should be noted that nearly £1,000 related to prepaid 1991 subscriptions.

ALAN SECCOMBE
Honorary Treasurer

RECORDER'S REPORT: MARINE MOLLUSCA

Further to my previous annual report (*J. Conch., Lond.* **33**, p. 375), there is now confirmation that colonies of the North American razor shell *Ensis americanus* (Binney) are living along the North Norfolk coast, sea area S12 (D. J. Howlett, *Conch. Newsletter*, **114**, pp. 301-2).

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND
12 MONTH ACCOUNTING PERIOD ENDED: 31.12.90

BALANCE SHEET

	Year ended 31 December 1990 £	Year ended 31 December 1989 £
<i>Assets</i>		
Investments	17,662.51	17,662.51
Cash	6,978.09	6,022.35
	<u>24,640.60</u>	<u>23,684.86</u>
 <i>Liabilities</i>		
Creditors and accrued charges	815.00	2,072.73
Advance subscriptions	924.00	766.00
Life members fund	3,800.00	3,000.00
Reserve and research fund	3,747.10	2,976.08
Publicity reserve	400.00	—
	<u>9,686.10</u>	<u>8,814.81</u>
	<u>14,954.50</u>	<u>14,870.05</u>
 Represented by:		
Capital Account brought forward	14,870.05	16,485.07
Profit/(loss) for the year	84.45	(1,615.02)
	<u>14,954.50</u>	<u>14,870.05</u>

A. D. SECCOMBE (*Honorary Treasurer*)

A. N. LIGHT FCA

D. WORTH (*Honorary Auditors*)

PROCEEDINGS

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND
12 MONTH ACCOUNTING PERIOD ENDED: 31.12.90

INCOME AND EXPENDITURE ACCOUNT

	Year ended 31 December 1990 £	Year ended 31 December 1989 £
<i>Income</i>		
Fees and subscriptions	10,611.99	9,075.10
Investment income	3,852.45	3,162.81
Donations	292.95	563.29
Sales	100.94	239.25
Gain on repayment of investments	—	99.51
Sundry income	45.20	25.00
	<u>14,903.53</u>	<u>13,164.96</u>
<i>Expenditure</i>		
Publication costs	9,421.28	13,140.23
Stationery and postage	2,181.33	977.03
Members' list	500.40	687.17
Meetings	480.00	480.00
Sundry	265.05	359.34
	<u>(12,848.06)</u>	<u>(15,643.77)</u>
Excess of income over expenditure	<u>2,055.47</u>	<u>(2,478.81)</u>
Transfer to publicity reserve	(400.00)	—
Transfer (to)/from Reserves (Reserve and Research Fund)	(771.02)	973.81
(Life Members' Fund)	(800.00)	(110.00)
Profit/(loss) for the year	<u>84.45</u>	<u>(1,615.00)</u>

Recent records of marine molluscs are mainly from the North Sea (Jean Paul Kreps of Belgium), Ireland (Julia Nunn) and South Wales, sea area S21 (Shelagh Smith), while work by Per Bie Wikander on the *Mollusc Fauna of the Norwegian Skagerrak Coast I and II* (Oslo, 1989 and 1990) has provided detailed knowledge of the north west part of sea area S50 Fisher and the adjacent Baltic.

A regional atlas covering West Scotland and North Ireland by S. M. Smith, D. W. McKay and J. D. Nunn is in preparation, and a provisional atlas intended to stimulate further work in sea area S15 Wight has been produced by the area representative Mrs. J. M. Light.

It is to be hoped that some nomenclatural stability will be provided by the imminent publication of a new British species list by S. M. Smith and D. Heppell, which will include much discussion and an extensive list of synonyms.

I have brought the 1982 *Sea Area Atlas* up-to-date and considerably extended the area covered, and this work has now been published for the Society's marine census as the *Distribution of the marine molluscs of north west Europe* (NCC., Peterborough, 1990). This lists and describes the distribution of all the marine molluscs recorded from the waters around Britain and Ireland, from the Faroes and Bergen in the north to Brest in the south, including the North Sea and an area of the Atlantic into deep water.

I have now resigned as Marine Recorder to the Society, having held the post since 1979. During that time there has been a fruitful collaboration with NCC, resulting in publication of provisional species lists for all the areas in 1979, the *Sea Area Atlas* in 1982, and *north west Europe* in 1990. These form a basis which should allow the census to concentrate upon new records and more detailed regional studies, such as the pioneer *East Scotland atlas* of McKay and Smith.

I thank previous marine Recorders, and area representatives, members and many correspondents, for all their help during my term of office.

D. R. SEAWARD

RECORDER'S REPORT: NON-MARINE MOLLUSCA

A. Mapping Schemes

The setting up of tetrad (2×2 km square) mapping schemes has clearly stimulated interest in non-marine recording. There are schemes for Devon, the Isle of Wight, Kent, Suffolk, Bedfordshire, Northamptonshire, Carmarthenshire and Cardiganshire, as well as some more local projects, though none as yet in Scotland or Ireland. Specially welcome is the mapping scheme recently organised for Devon (v.c.s 3 and 4) by Michel Hughes and David Bolton; the coverage already achieved is giving a clear picture of distribution patterns in this large county straddling the highland and lowland zones with its unusual mixture of biogeographical elements.

Ten years ago, one may note, Devon and Cardigan were singled out as two of the three most poorly known counties for molluscs in England and Wales (the third being Nottingham; *J. Conch., Lond.* **31**, p. 132).

The new, definitive edition of the national *Atlas*, long promised, should be substantially ready for the press during 1991.

B. Vice-county records

The following new vice-comital records have been authenticated since the last Report (*J. Conch., Lond.* **33**, p. 378). They date from 1990–1 unless stated otherwise. All records are

incremental to the lists given in the last full edition of the *Census* (*J. Conch., Lond.* **31** (1982), p. 69).

- Devon South (3): *Lymnaea glabra*, Manaton (20/7582), D. E. Bolton.
 Devon North (4): *Ferrissia wautieri*, *Acroloxus lacustris*, Cruwys Morchard (21/8712), D. E. Bolton.
 Somerset North (6): *Segmentina nitida*, Long Ashton (31/57). J. R. Tomlin, before 1926 (probably 1884), BMNH.
 Hants North (12): *Myxas glutinosa*, Basingstoke Canal, Fleet (41/8353), D. Whiteley, 1969.
 Berks (22): *Gyraulus laevis*, Bourton (41/2386), D. Walker, 1988; *Boettgerilla pallens*, Little Wittenham (41/5693), S. J. Gregory.
 Oxford (23): *Vertigo substriata*, Elsfield (42/5509), S. J. Gregory; *V. moulinsiana*, South Stoke (41/5983), A. Spriggs; *Boettgerilla pallens*, Oxford (42/5406), S. J. Gregory.
 Norfolk East (27): *Limax tenellus*, Felbrigg Great Wood (63/1940), I. J. Killeen.
 Gloucester East (33): *Pisidium supinum*, *P. moitessierianum*, R. Avon, Tewkesbury (32/8832), D. C. Long.
 Carmarthen (44): *Aplexa hypnorum*, Laugharne Burrows (22/2807), A. O. Chater; *Vallonia pulchella*, Tywyn Burrows (22/3605), I. K. Morgan, 1985; *Cochlodina laminata*, Coed Penrhiwiau (22/6623), I. K. Morgan.
 Cardigan (46): *Vallonia pulchella*, Ynys-Las (22/69), C. Oldham, 1923.
 Flint (51): *Lymnaea stagnalis*, Tremeirchion (33/0771; garden pond), Mrs N. F. McMillan.
 Lincoln South (53): *Pisidium pseudosphaerium*, Metherringham Delph (53/1363), B. Coles.
 York Mid-west (64): *Helicodiscus singleyanus*, Grassington (34/9864), C. R. C. Paul, 1987.
 Isle of Man (71): *Acanthinula aculeata*, Glen Mooar (24/3088); *Vitrea crystallina*, *Boettgerilla pallens*, East Baldwin (24/3680); *Ceciloides acicula*, Ballasalla (24/2969), all P. Tattersfield.
 Ayr (75): *Arion flagellus*, Ardrossan Academy (26/2342), Glasgow Museum Survey.
 Lanark (77): *Anodonta anatina*, Lanark (26/9043), R. Nixon, 1989.
 Roxburgh (80): *Anodonta anatina*, R. Teviot, Denholm (36/5518), C. Badenoch, 1985.
 Edinburgh (83): *Vallonia pulchella*, Edinburgh (36/27), old collection, BMNH.
 Perth West (87): *Anodonta anatina*, Gartmorn Dam (26/9294), I. Findlay, 1988.
 Kincardine (91): *Anodonta anatina*, Fasque Loch (37/6575), A. Milne, 1989.
 Dunbarton (99): *Arion lusitanicus*, East Helensburgh (26/3082; garden), Glasgow Museum Survey.
 Mid Ebudes (103): *Vertigo antivertigo*, Ballyhaugh, Coll (17/1758), B. J. Musker; *Vallonia pulchella*, Calgary, Mull (17/35), L. B. Langmead, 1948.

There have been several interesting discoveries during the past year. *Helicodiscus singleyanus* in Yorkshire is an addition to the very few known British occurrences of this enigmatic subterranean snail and the most northerly. Apart from greenhouses, the previous finds are from Surrey (Kew), Bedford (Sandy, Whipsnade, Potton), Cardigan (Machynlleth), Cheshire (Burton) and the Channel Islands (Jersey). At Grassington three fresh shells were recovered from flood debris of the River Wharfe.

The rare slug *Limax tenellus*, previously unknown in East Anglia, was detected in north Norfolk, about a hundred miles from its nearest recorded sites in central England and around London. Its presence at Felbrigg emphasises the historical and conservation importance of this ancient pollarded beech/chestnut wood, a National Trust property.

Arion lusitanicus (*sensu stricto*) has been verified by Stella Davies from a garden in Dunbarton. The only other Scottish record remains that from the Necropolis cemetery, Glasgow.

Cochlodina laminata, mainly a snail of the lowland zone, has been found at an isolated site

in Carmarthenshire in a base-rich wood in a mountain dingle. *Vertigo moulinsiana* from Oxfordshire also extends our knowledge of the range of a very local (and declining) species.

Some noteworthy freshwater records have come to light. Shells of *Segmentina nitida* from Somerset, collected probably in 1884, add to our sparse knowledge of the former range of this now endangered rarity. A fairly fresh shell of *Myxas glutinosa* collected from the Basingstoke Canal near Fleet in Hampshire in 1969 shows that the species may once have been frequent in this waterway, from which there are pre-1914 records from further east in Surrey. *Lymnaea glabra* in v.c. 3 confirms an unlocalised Census record of about 1875 from 'South Devon'. Lastly, the introduced limpet *Ferrissia wautieri* has been found in a pond in North Devon, adding to the dozen or so sites reported for this species since its discovery in Britain in 1977.

Among the bivalves, the outstanding find of 1990 was the discovery in Lincolnshire of *Pisidium pseudosphaerium*, a rare species still imperfectly known. The habitat was a swampy drainage dyke. The several new records of *Anodonta anatina* in Scotland results from the work of the Scottish Mussel Survey (see *Conchol. Newsletter* No. 106, p. 124). All were verified from specimens submitted to Mr. F. R. Woodward and now lodged in Glasgow Museum.

M. P. KERNEY

COMMUNICATIONS

APLYSIA DEPILANS GMELIN AND A. FASCIATA POIRET FROM CORNWALL

On 4 October 1990, whilst monitoring transects in Gillan Harbour, Helford (NGR SW782254) Mr Brian and Mrs Elizabeth Jackson noted and photographed a large *Aplysia*, which was unlike the commonest British species *A. punctata* with which they were both familiar. After viewing the photograph, and discussing the appearance and behaviour of the animal with Mr Jackson, Dr Alan Bebbington identified it as *A. fasciata*. At much the same time two other specimens of *A. fasciata* were sighted near the ‘Mayflower steps’ on the Barbican, Plymouth and Mr A. Frettsome collected one of the specimens for the Plymouth Laboratory. The only previous record of this species in the south west was from Salcombe Estuary reported by Grigg, as *A. limacina*, in February 1949 (*J. mar. biol. Ass. U.K.*, **28** (1959) pp. 795–805).

The following month, on 11 November 1990, Mr Neil Kennedy found about 50 of another species of *Aplysia* on Castle Beach, Falmouth (SW819319) with a further 25 or so on nearby Swanpool Beach (SW803312). All were on the strandline, evidently dying and being generally larger in size than *A. punctata*. Dr Paul Gainey, after preserving and dissecting a few specimens, considered them to be *A. depilans*. This conclusion was later confirmed by Dr Bebbington who had recently examined another specimen which had been washed ashore on Exmouth Beach (SX999805) on 18 October 1990: the Exmouth specimen of *A. depilans* is now in the Exeter Museum reference 384/1990. In mid-November Dr Gainey found large quantities of pinkish spawn in short strings on the strandline, similar to that of *A. punctata*. It seems likely that this was the spawn of *A. depilans* which had been laid by the moribund animals found previously. *A. depilans*, like the rarer *A. fasciata*, is only found occasionally and it is so far recorded in British Waters only from Sea Areas 15, 16, 17 (Channel Isles), 18, 21, 27 and 36. Up to now, its Cornish status has rested on two 19th century records. Dr Jonathan Couch found it at Polperro and described it under the name *A. melanopus* (*Proc. zool. Soc. Lond.*, (1870) pp. 173–175); the holotype is in the Natural History Museum, London, reference 1870.1.14.20. Dr W. P. Cocks (*Rep. R. Cornwall polyt. Soc.*, **17** (1849) p. 60) reported it as being “not uncommon” in Falmouth Harbour and Gyllyngvase Beach (which is next to Castle Beach); this seemed rather unlikely until this 1990 report of large numbers.

The three species of *Aplysia* referred to in this communication, *A. depilans*, *A. fasciata* and *A. punctata* belong to different sub-genera and as such can, except during their juvenile stages, be readily distinguished from each other. Grigg (*J. mar. biol. Ass. U.K.*, **28** (1949), pp. 795–805) gave a figure showing the differences in their body outlines and Bebbington & Thompson (*Act. Soc. linn. Bordeaux*, **105** (1968), pp. 1–35) illustrated and gave a table summarising their main features. Bebbington’s figures also appear in Thompson (*Biology of Opisthobranch Molluscs*, vol. 1. Ray Society, London, No. 151, pp. 1–207) on pages 137–160. Eales (*Bull. Br. Mus. nat. Hist. (Zool)*), **5** (1960), pp. 269–404) revised the World species of *Aplysia* and gave a full synonymy of the genus.

ALAN BEBBINGTON
3 Crawley Lane, Uley, Nr Dursley, Glos GL11 5BJ
and
STELLA MARIS TURK,
‘Shangri-la’, Reskadinnick, Camborne, Cornwall, TR14 0BH.

CODAKIA DECUSSATA (LUCINACEA: LUCINIDAE) FROM CORNWALL AND THE ISLES OF SCILLY

Two decades ago the widow of T. G. W. Fowler (1880–1967) presented three cases of her husband’s shell collection to the Isles of Scilly Museum after the bulk had been given to the Natural History Museum, London in May 1965. We learn from his obituary (McMillan *J. Conch.*, *Lond.* **26** (1968) p. 333) that Mr Fowler’s interest in Mollusca started in 1927 and that he collected only British shells. Most of these came from Cornwall and the Isles of Scilly. Unfortunately, in many instances he boxed specimens with two localities on the label. In June of this year (1990) I sorted the collection in the Isles of Scilly Museum and discovered two specimens, with joined valves, of the lucinid *Codakia decussata* (O. G. Costa, 1829). They were in a box with a number of miscellaneous unnamed and undated shells bearing the label ‘Scillies and Helford’. The fact that this species occasionally occurs alive in the Scillies is

borne out by the existence of a specimen in the A. E. Salisbury collection in the Merseyside Museums described by McMillan (*J. Conch., Lond.* **27** (1971) p. 266) as "live-taken". It was labelled "Scilly, deep water, 40 fm." Also in the Salisbury collection was a single valve from "Towan beach, Falmouth, 1912". As many bivalves live for a considerable period, it needs only an occasional favourable year to ensure some success in spat-fall. In the Fowler collection in the Isles of Scilly Museum, were a number of valves of another 'Mediterranean' lucinid, *Lucinella divaricata* (L.), four examples of which were found, living, on the shore of Trescò in 1949 and 1950 (Fowler *J. Conch. Lond.* **23**, pp. 68, 98 & 266). If there is indeed global warming, one can expect more such 'southern' species to be added to the British list.

I am grateful to Mrs. N. F. McMillan for checking the identity of *Codakia decussata*.

STELLA MARIS TURK.

'Shang-ri La', Reskadinnick, Camborne, Cornwall TR14 0BH

FURTHER NOTES CONCERNING *VALLONIA ENNIENSIS* (GREDLER)

In a previous note Gittenberger (*J. Conch. Lond.* **33** (1989) p. 186) has referred to a paper by Haas (*Trab. Mus. Cienc. Nat. Barcelona*, **13** (1929) p. 319) for the first records of *Vallonia enniensis* (Gredler, 1856) from Spain. As a matter of fact, Haas had actually published the same data six years earlier (*Senckenbergiana*, **5** (1923) p. 55). However, in another paper from 1929 he made public the first two localities from the province of Zaragoza (*Mem. R. Soc. esp. Hist. nat.*, **15** (1929) p. 581), although the authenticity of these records has been doubted (Preece, *J. Biogeogr.* **18** (1991) pp. 409–426).

Haas (1923 p. 54) also referred to several older papers for records of *V. enniensis* (usually as *V. costellata* Sandberger) from Eastern Europe and S. W. Asia. From the latter area he repeated Hesse's record from Adana, Turkey (*Nachr. Bl. D. Malak. Ges.*, **46** (1914) p. 57), which has remained the only find in the Levant.

During a visit to the former swamps of the lower Nahal Soreq basin east of Palmahim, Israel, i.e. the Wadi Rubin area, in the autumn of 1988, we were able to extract some mollusc material from the debris laying on the banks of a recently cleaned drainage ditch: Ta'alat Rubin. The material was rather heterogeneous in composition and obviously consisted of a mixture of fossil (? Late-Pleistocene) and recent land- and freshwater shells. Among the terrestrial species we could record among others fair numbers of both *Vallonia enniensis* and *Vallonia pulchella* (Müller, 1774), and a single *Euconulus fulvus* (Müller, 1774): all species not known to occur in Israel today (Mienis, *Levantina*, **39** (1982) p. 457–465).

This new locality for *V. enniensis* is situated some 560 km south of Adana. This means that once *V. enniensis* had a much more southern distribution in the countries bordering the Eastern Mediterranean than today. Hopefully the problems concerning the age of this material can be clarified in the near future.

HENK K. MIENIS,

Mollusc Collection, Zoological Museum, Hebrew University, 91904 Jerusalem, Israel

ON THE DATE OF PUBLICATION OF LOWE'S "*PRIMITIAE ET NOVITIAE FAUNAE ET FLORAE MADERAE ET PORTUS SANCTI*"

R. T. Lowe published in 1831 an account of the flora and terrestrial mollusc fauna of Madeira and Porto Santo (*Trans. Camb. phil. Soc.*, **4** pp. 1–66, pls. 1–6). This work was followed by a second account of the Madeiran flora by the same author in 1838 (*Trans. Camb. phil. Soc.*, **7** pp. 523–551). Since both studies were rather difficult to procure, he published a reprint of these works with an appendix in book-form under the title: "*Primitiae et Novitiae Faunae et Florae Maderae et Portus Sancti or Two memoirs on the Ferns, Flowering Plants, and Land Shells of Madeira and Porto Santo . . . with an appendix* (I–XVI + 1–66 + 523–551 + I–XXVII pp., 2 plts. – molluscs only! – J. van Voorst, London).

This work is usually quoted as having been published in 1851, which date is indeed given on the title page. Ruhoff (*Smiths. Contr. Zool.*, **294** (1980) pp. 1–640) for example mentioned it as the date of publication, but she failed to list any of the following eight names, apparently introduced for the first time in the appendix:

<i>Vitrina behnii</i> (p. VII, note 52)	<i>Helix papilio</i> (p. IX, note 70)
<i>Helix vulgata</i> (p. VII, note 61)	<i>Achatina oryza</i> (p. IX, note 76)
<i>Helix armillata</i> (p. IX, note 64)	<i>Bulimus maderensis</i> (p. X, note 77)
<i>Helix lincta</i> (p. IX, note 66)	<i>Helix canicalensis</i> (p. X, footnote)

In fact Ruhoff referred all names, except *Vitrina behnii*, to another work by Lowe (*Ann. Mag. nat. Hist.*, (2) **9** (1852) pp. 112–120, 275–279).

COMMUNICATIONS

The *Vitrina* she did not list at all. However, Groh & Hemmen (*Arch. Molluskenk.*, **116** (1986) pp. 183–217) mentioned *Phenacolimax (Madeirovitrina) behnii* as having been described by Lowe in 1851. If that date is correct, then all the names enumerated above should bear the date 1851!

So far all students of Madeiran molluscs seem to have overlooked the fact that on page XVII of the appendix, Lowe quotes a letter from Owen dated Feb. 24, 1853! It is therefore quite impossible that the book was published in 1851. Moreover our copy (ex Arthur Blok Library) is dedicated by the author to a certain Anderson Bart and dated 23 May 1853. This supports the idea that this work was published in reality somewhere between the end of February and the end of May 1853.

Since all the names mentioned above, including *Vitrina behnii*, were used also by Lowe in his 1852 paper, they should bear that year as official date of publication.

HENK K. MIENIS,
Mollusc Collection, Zoological Museum, Hebrew University, 91904 Jerusalem, Israel

FURTHER NOTES ON *LEPTOCHITON SCABRIDUS* (JEFFREYS)

This chiton is a southern species with a recorded distribution from five Sea Areas off SW England [Seaward, *Distribution of the marine molluscs of north west Europe*, NCC, Peterborough (1990)]. Also included was a record from Donegal (Light & Baxter, *J. Conch., Lond.*, **33** (1990), p. 318) thus extending the known range of this species. Further specimens have been found by David McGrath in Galway Bay (J. Baxter, pers. comm.)

During the course of fieldwork for our Isle of Wight survey, specimens of *Leptochiton scabridus* were found living at Bembridge Foreland, on the east coast of the Island (50°41'N, 01°03'W). In many respects the habitat resembles that of the Donegal site at Broad Water (55°10'N, 07°03'W), discovered in June 1989. The Bembridge Ledge system is very sheltered consisting of an extensive series of slow-draining Bembridge Limestone terraces. At low water there are numerous pools and larger areas of standing water. The effect of continual draining during ebb gives rise to rapids at the lowest level of the ledge system. Several specimens of the chiton were found attached to the undersides of large, relatively flat limestone boulders which were well embedded in coarse sand and shell gravel within one of the lowest, larger pools. Further work will determine the extent of the colony.

It is interesting to note that this is the second so-called rare species with an apparently restricted distribution which includes the Channel Islands, that has been recorded from the southern side of the Isle of Wight. This follows our discovery of *Arculus sykesi* at Compton in 1989 (*J. Conch., Lond.*, **33** (1990), p. 317). It may be that these finds are the result of detailed fieldwork uncovering small previously overlooked species. However it is also possible that they are species which are extending their range northwards.

We would like to thank John Baxter for looking at the specimens and confirming our identification.

JANICE M. LIGHT¹ and IAN J KILLEEN
¹88 Peperharow Road, Godalming, Surrey, GU7 2PN, England

NOEMIAMEA DOLIOLIFORMIS (JEFFREYS) AND *GRAPHIS ALBIDA* (KANMACHER) LIVING AT CRICCIETH, NORTH WALES

During the joint field meeting to Anglesey with the Porcupine Society which took place in October 1990, a visit was made to the shore west of Criccieth Castle on the Llyn Peninsula (52°55'N, 04°13'W). The steep shore consists of pebbles and large stones with a lower shore of large, closely-packed rocks. Many of the rocks were resting on coarse sand and gravel. Close inspection of the substrate beneath these rocks revealed significant numbers of *Onoba semicostata*. A 0.5 litre sample of the sediment was collected for later examination in the hope of recording *Alvania crassa*, a species we have found elsewhere in similar sediment samples.

The sample was washed over a 4 mm sieve and the residue preserved in alcohol. Microscopic examination yielded live-collected specimens of *Alvania crassa*, *Alvania semistriata*, *Odostomia plicata*, two specimens of *Noemiamea dolioliformis* and one *Graphis albida*.

The last two species are particularly noteworthy because recent live records are sparse in both cases. In the British Isles *Noemiamea dolioliformis* has only been recorded alive in S16 and S21 before 1951 (*Distribution of the marine molluscs of north west Europe*, NCC, 1990) and Roscoff, NW France, (*Cah. Biol. Mar.*, **16** (1974) p. 83–96).

There are post-1950 live records for *G. albida* from Roscoff (*op. cit.*), Teignmouth, Devon, 50°32'N, 03°29'W, (*J. Conch., Lond.*, **32** (1987) p. 386) and Fanore, Co. Clare, Ireland (*Conchologists' Newsletter*, **111**, (1989) p. 242–245).

Little is known about the habitat and biology of *Noemiamea dolioliformis* but previous accounts have described it as living in rockpools and on weeds at LWST. Ecological knowledge of *Graphis albida* is similarly vague, however a prominent feature of the shores at Fanore, Teignmouth and Criccieth is the presence of extensive colonies of the tube-building polychaete, *Sabellaria alveolata*. A search for further finds of *Graphis*, in particular, might be focussed on sediment and red weed samples from shores where *Sabellaria* is present.

JANICE M. LIGHT¹ and IAN J KILLEEN
¹88 Peperharow Road, Godalming, Surrey, GU7 2PN, England

INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr R. C. Preece, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ.**

PAPERS Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

Journal of Conchology

Vol. 34, Part 2, January 1992

Contents

	PAGE
PAPERS	
D. MINCHIN—Observations on shell colour in the Scallop, <i>Pecten maximus</i> (L.)	41
M. T. APARICIO, M. B. SEDDON and D. T. HOLYOAK—Systematics and Distribution of <i>Helicopsis</i> (<i>Xeroleuca</i>) in Morocco (Mollusca: Gastropoda: Helicidae)	47
R. S. K. BARNES—On the Distribution of the northwest European Species of the Gastropod <i>Hydrobia</i> , with particular reference to <i>Hydrobia neglecta</i>	59
M. S. YOUNG and J. G. EVANS—Modern Land Mollusc Communities from Flat Holm, South Glamorgan	63
A. C. VAN BRUGGEN—Bridging the Gap: <i>Parrennea</i> (Pulmonata: Streptaxidae) in Nigeria	71
W. WELLENS— <i>Coriocella hibyae</i> . A new <i>Lamellaria</i> species (Gastropoda: Prosobranchia) from the Republic of the Maldives	73
B. VERDCOURT—A new <i>Anostoma</i> from Brazil (Gastropoda: Pulmonata: Bulimulidae)	81
F. FERNANDES and E. ROLAN—The Marginellidae (Mollusca: Gastropoda) of Principe Island (Republica de São Tomè e Principe)	85
J. LUCEY, M. L. MCGARRIGLE and K. J. KLABBY—The Distribution of <i>Theodoxus fluviatilis</i> in Ireland	91
F. R. WOODWARD—Notes on Naid Taxonomy (Bivalvia: Unionoida) 2. The Genus <i>Prisodontopsis</i> Tomlin, 1928	103
COMMUNICATIONS	
A. BEBBINGTON and S. M. TURK— <i>Aplysia depilans</i> Gmelin and <i>A. fasciata</i> Poiret from Cornwall	115
S. M. TURK— <i>Codakia decussata</i> (Lucinacea: Lucinidae) from Cornwall and the Isles of Scilly	115
H. K. MIENIS—Further notes concerning <i>Vallonia enniensis</i> (Gredler)	116
H. K. MIENIS—On the Date of Publication of Lowe's " <i>Primitiae et Novitiae Faunae et Florae Maderae et Portus Sancti</i> "	116
J. M. LIGHT and I. J. KILLEEN—Further notes on <i>Leptochiton scabridus</i> (Jeffreys)	117
J. M. LIGHT and I. J. KILLEEN— <i>Noemiamea dolioliformis</i> (Jeffreys) and <i>Graphis albida</i> (Kanmacher) living at Criccieth, North Wales	117
REVIEWS	83
PROCEEDINGS	107

Journal of Conchology

. 34, Part 3

ISSN 0022-0019

May 1992



**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN
AND IRELAND**

51 Wychwood Avenue, Luton, Bedfordshire LU2 7HT

Hon. Secretary: Mrs S. DAVIES,
5, The Deans, Portishead, Bristol BS20 8BG

Hon. Treasurer: Mr. A. SECCOMBE,
36a Selborne Road, Ilford, Essex IG1 3AJ

Hon. Editor: Dr. R. C. PREECE,
Department of Zoology, University of Cambridge,
Downing Street, Cambridge CB2 3EJ.

Member's subscription: £21 per annum. **Entrance fee:** £1.

Family membership: £23 per annum.

Institutional membership: £30 per annum.

Students membership: £10

Meetings are held at the British Museum (Natural History) at 2.30 p.m. usually on the third Saturday of each month from October to May. Field Meetings are held in the summer.

Publications: Members receive

The Journal of Conchology (usually two numbers a year).

The Conchologists' Newsletter (quarterly).

For back-numbers of these publications and special numbers please apply to Mr A. Norris, Leeds City Museum, Municipal Buildings, Leeds LS1 3AA.

Programme Secretary: Mr. I. J. KILLEEN, 163 High Road West, Felixstowe, Suffolk IP11 9BD.

Marine Census Recorder: Mrs. J. LIGHT, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN.

Non-marine Census Recorder: Dr. M. P. KERNEY, Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD.

Newsletter Editor: Mr. P. LEE, Rochdale Cottage, Camps Heath, Lowestoft, Suffolk NR32 5DW.

COVER DESIGN: *Muricanthus nigratus* (Phillippi) by D. G. Reid.

NOTICE

Payment by Overseas Members

Overseas members are reminded that all monies due to the Society are payable in sterling.

MOLLUSCA IN FICTION (II)

M. FOGAN¹

PRESIDENTIAL ADDRESS

(Read before the Society, 16th March, 1991)

Possibly the earliest mention of a shell-collector in English fiction appears in *The Smuggler*; a deservedly obscure three-volume novel published anonymously in 1831. This concerns the daughter of a powerful and successful smuggler, whose ill-gotten gains have provided her with some degree of education. She attempts to dazzle the revenue officer with a display of her accomplishments, including noisy piano-playing and an invitation to see her shell collection. This, however, appears to be little more than a fashion accessory to her flashy style of dress and is faintly reminiscent of conversation on “taste, Shakespeare and the musical glasses” in *The Vicar of Wakefield*.

The nineteenth century has been described as the “heyday of natural history” and during this period there was probably more general interest in various branches of natural history than at any other time. Conchology was not only popular, it was also fashionable. The shell cabinet was a prominent ornament of many Victorian drawing-rooms; Ruskin wrote of the young beauty relaxing from a hectic social life among her flowers and shells. There was an aquarium craze, initiated by the popularity of the writing of P. H. Gosse, and there was publication of conchological books of every kind, ranging from such splendid publications as the *Conchologia Iconica* to B. B. Woodward’s *Young Collectors Handbook of Shells* which was published in 1883 at the price of one penny and which must have a strong claim to be the cheapest conchological manual ever produced.

Since this was also the age of the great Victorian novelists it is something of a mystery that the subject is mentioned by so few. The answer may possibly be that it was regarded as too frivolous. George Eliot, in *Middlemarch*, has a brief and somewhat scornful reference: Mr. Casaubon when convalescent is told “You must unbend, you know. Why, you might take up some light study: conchology, now; I always think that must be a light study. Or get Dorothea to read you some light things, Smollett – *Roderick Random* or *Humphrey Clinker*.” Admittedly this speech was put into the mouth of a decidedly foolish character, but it was not an isolated opinion. Hugh Miller the geologist, writing to his wife, suggested that she might amuse herself by studying shells (geology presumably being beyond her) and the observations of George Johnson in his *Introduction to Conchology* are surprising. This solid work of over 600 pages, praised by S. P. Dance as being “full of useful information” begins by saying in the preface “You are not going to follow it out as the chief object of your life – that were to do what I could not commend – but as a recreation to relax and refresh the wearied mind, as a resort to fall back upon in those hours of idleness which will overtake the busiest of us all” and concludes the book “Be careful, in conclusion, to ride your hobby leisurely and at a pleasurable pace. It is neither for you nor me to devote our time to natural history: – it is to be your recreation.”

One might, nevertheless, have expected a less dismissive attitude from George Eliot, in view of her long association with G. H. Lewes who was keenly interested in marine biology. Possibly a clue may be found in his *Seaside Studies*. In the chapter on Tenby he describes a dredging expedition with a lady who became extremely sea-sick. George Eliot had

¹ 181 New Brook Road, Atherton, Manchester M29 9HA

accompanied Lewes to Tenby and was almost certainly the victim; this unhappy experience might have acted as a deterrent – perhaps she aimed a sly dig at Lewes. Certainly she did not display the same dismissiveness to every branch of natural history; in *Middlemarch* the curate, Mr. Farebrother, is a serious entomologist and his work is regarded with respect.

A Victorian novelist who might have been expected to deal with conchology, and more kindly, was Charlotte M. Yonge. She was interested in natural history, publishing *The Herb of the Field* (a book on botany) and editing the English edition of *The Population of an Old Pear Tree, or Stories of Insect Life* from the French of E. Van Bruyssel. Moreover, in the short autobiography describing her childhood (published in Christabel Coleridge's *Charlotte Mary Yonge*) she writes of her shell collection: "I had a great passion for shells, and had at home really striven to learn their names and the system of arrangement. . . . No present was so delightful to me as a shell. . . . Grandmamma Yonge gave me a fine wentletrap, and my father spent many a shilling and even half-a-crown on shells. Many more dropped by chance and I have for many years had a really good collection." (This collection was maintained throughout her life, and was left to Winchester College.) In many of her novels characters are shown botanizing, collecting insects, fossils, and even sea-anemones, but she does not appear to have introduced a shell-collector. Some years ago I enjoyed a conversation with Professor C. M. Yonge (later Sir Maurice) who told me that he was a remote connection of Miss Yonge, and we both regretted that she had not done so. Since she was an extraordinarily prolific writer, producing hundreds of works on an astonishing variety of subjects, it is not impossible that she did in one of her lesser-known works. *The Herb of the Field* is a collection of papers reprinted from the *Magazine for the Young*: she edited and contributed to a number of obscure publications and some day a conchological paper may come to light. To judge from *The Herb of the Field* it would be unlikely to be of scientific value, since that contained such gems as "Does it not show that oranges were made for our especial benefit, that there should be so many without pips, so as to be of no use at all excepting for food?"

Miss Yonge did introduce a pearl into one of her most successful novels, *The Daisy Chain*, as a fairly heavy piece of symbolism. The reader is frequently reminded that the name "Margaret" means "A pearl". The invalid Margaret May is given a pearl engagement ring by her sailor fiance before he departs for the South Seas where he is wrecked and dies. His money is left to found a church, and the dying Margaret asks for her ring to be set in the chalice.

Two further works by Miss Yonge, *The Chaplet of Pearls* and its sequel *Stray Pearls* have little to do with pearls as such. They are historical romances concerned with the French family of Ribaumont and its French and English connections. Between them they cover a stretch of French and English history between the massacre of the Eve of St. Bartholomew and the Restoration of Charles II. The various characters contrive between them to be present at an incredible number of historical events. The eponymous pearls, a family heirloom, are mentioned occasionally as being passed from one character to another.

The Glory of the Sea by "Darley Dale" (Miss F. A. Steele) is frequently cited as the great conchological novel, but unhappily one is driven to the conclusion that Miss Steele was something of a natural history hack writer. She also wrote *Mr. Mygale's Hobby, a Story about Spiders* (with a list of British Spiders) and *Swallowtails and Skippers* (with a list of British Butterflies). Described by S. P. Dance as "responsible for several morally uplifting tales" she would seem to have been more concerned with instruction than with moral uplift, and as all three works are listed by Freeman one must conclude that she was reasonably efficient.

The plot of *The Glory of the Sea* is in the main a string to which a series of lectures are attached, but such plot as exists is not even original. T. E. Crowley drew attention to the similarity with Wilkie Collins' *The Moonstone* where the loss of a valuable object is due to the actions of an innocent sleep-walker, but it does not appear to have been observed that the

whole plan of the book bears a close resemblance to a little work, *The Rudiments of Conchology*, published anonymously by Miss M. A. Venning in 1826. Miss Venning did not pretend that she was writing anything other than a text-book, but must have felt, like Alice in Wonderland, that books should have pictures and conversations.

In each book the subject of conchology is introduced by the unexpected acquisition of a shell-collection; Poppy Merton's is left to her by her godmother while Lucy Elliott's is a present from a cousin. Poppy (at first very reluctantly) and Lucy (eagerly) then proceed to learn about shells, Poppy from an admirer and Lucy from her father. Unfortunately Miss Venning does not make much of her characters; Lucy and her brother have very little to do apart from feeding Mr. Elliott with the right questions, but even so it must be admitted that Lucy compares favourably with Poppy. Poppy will not hear about slugs – "I don't care to hear about them; they have no shell" but Lucy takes them in her stride and speculates about the shield; Poppy will not be told about pond snails: "Horrid creatures! I don't care much for them" but Lucy is resolved to collect in "our own coasts, rivers and ponds, hedgebanks, heaths and other places." Sadly one infers that Poppy will end up with a handsome collection, but Lucy will be entitled to call herself a conchologist.

Although only a very slight sketch the most interesting character in Miss Venning's book is Mr. Elliott, who is extraordinarily advanced for his time. He tells Lucy she can read Lamarck's *Histoire Naturelle des Animaux sans Vertèbres*. "It is in French and Latin!" complains Lucy. "Why do you both look so serious?" asks their father "Are you not students in these useful languages?" Later he observes "I should consider a young person of your age, Lucy, very ignorant who could not read and understand the general style of Lamarck with the occasional aid of the dictionary." French, certainly – but how many girls were taught Latin in 1826? Mr. Elliott is also a remarkably early conservationist, telling his children "I do not approve of any animal's life being taken away in order to obtain its habitation. Empty shells may be found which will serve perfectly well for specimens" and he has quite a modern approach to the subject of cleaning shells, suggests a little warm water and soap, mentions other processes but ends "But do not make a practice of polishing; shells are best in their natural state." One wishes one could have heard more of Mr. Elliott.

Although it occurs in a work of fiction one might hesitate to describe Herman Melville's description of the sighting of a giant squid as fictional. Unlike many writers of sea stories he had actually sailed as a hand on a whaling ship. The theme of the hunt for the white whale by the obsessed Captain Ahab is well known, but it is not often appreciated that *Moby Dick* is also a compendium of information, practical and theoretical, about whales and other forms of marine life. One whole chapter (*Squid*), albeit a very short one, is devoted to the sighting of a giant squid on the surface, and it is probable that Melville either saw one or was told of it by a shipmate who had done so. His description of the floating squid as "furlongs in length" is obviously exaggerated, but this is doubtless the effect which could be produced by a first impression. The sailors discuss this sight, saying that it is of great rarity; they feel it must be a portent of great good fortune or great misfortune.

When Shakespeare made Othello, after murdering Desdemona, say that he

"Like the base Indian threw a pearl away

Richer than all his tribe"

presumably Othello (and Shakespeare) felt that the Indian would have kept the pearl had he been wiser. This opinion is reversed in John Steinbeck's short novel *The Pearl*. Kino is a poor Indian fisherman with a wife, Juana, and baby son. When the baby is stung by a scorpion the doctor refuses to treat him, knowing that the father is too poor to pay, Kino goes to the local pearl-fishery to search for a pearl to enable him to pay; he does find a large oyster which contains a large and valuable pearl. A simple man, he rejoices that he will be rich; he will be able to pay to marry his wife in church, he will buy himself a rifle and his son shall go to school and learn to read.

The finding of the pearl becomes known in his village, and Kino's life is ruined. The priest exacts money for the church; the doctor hurries to attend "his patient" although the child has now recovered. Robbers come at night to try to steal the pearl. The local pearl-buyers are all in collusion, tell Kino his pearl is worthless and offer a derisory price. Thieves try again and Kino is injured in fighting them off. Juana says the pearl is evil and should be thrown away, but her husband is determined to go in his canoe to sell it in the city. Next day Juana tries to creep out to throw it away, but Kino catches her and beats her. He is attacked, and in self-defence knifes and kills the assailant. They must flee now, but discover that the canoe has been destroyed and they are forced to travel by land. They are followed by trackers, and Juana hides with the baby while Kino ambushes the trackers: he succeeds in killing them, but a random shot has killed the baby. Silently and in despair the parents return to the village with their dead child. Kino is now convinced that the pearl is evil. He throws it into the sea and watches it sink into the sand.

The Pearl Lagoons or the Lost Chief by Robert Macdonald adopts a totally different approach to pearl-fishing, being what is described as "a rattling yarn" and one of the more incredible examples of its genre. Jack and Charlie, two eighteen year-olds, having invented, built and patented an electrically-powered one-man submarine set out for the South Seas at the request of Charlie's rather dubious uncle. The submarine, armed with a powerful suction device, is to scoop up pearl shell, and as the pearl bank is situated in an area claimed by Germany it would seem to be something of a poaching expedition. Pursued by a gang of adventurers seeking both the submarine and the location of the pearling banks the gallant pair finally meet with Uncle Alexander's friends and indulge in a little pearling. The pearl-shell is raised by the ton, the submarine proving a great success and easily driving off a huge octopus with its electrical equipment. The gang of adventurers reappears, and it transpires that the pearling has been merely a blind; they have been engaged to claim the island for Germany. But Uncle Alexander now makes his appearance, disguised as a native chief, and announces that he has already claimed it for Britain. They acquiesce with great good humour, invite Uncle Alexander to become their chief and everyone is happy when he declares that he will reform them on the profits of the pearling.

Pearls appear in many stories simply as objects of value. An example is *The Adventure of the Six Napoleons* by A. Conan Doyle. Scotland Yard is puzzled by a series of four burglaries in each of which the only article stolen is a plaster bust of Napoleon, and can only imagine that they have been committed by a madman with a fanatical hatred of the emperor, since the busts are all found smashed. Sherlock Holmes is able to trace the provenances of the busts, which are all from one batch of six. The thief, who is also a murderer, having killed while stealing the fourth bust, is ambushed by the police while trying to steal a fifth. Holmes advertises for the sixth bust, buys it and smashes it to reveal "the famous black pearl of the Borgias". This had been stolen a year previously by a workman employed in the manufacture of plaster busts, who in danger of arrest for an earlier crime had concealed it by pushing it into a batch of damp plaster from which six busts were made. He was arrested and served a year's prison sentence; on release he had no means of knowing which contained the pearl and tracked them down one by one. He might be considered unfortunate in having been unsuccessful in five attempts out of six! Here the fact that the stolen jewel is a pearl is immaterial, and indeed Conan Doyle had made use in an earlier story of a similar ruse, in which a fugitive thief fed a stolen jewel to one of a flock of geese and failed to identify the right bird.

In *The Necklace of Pearls* by Dorothy L. Sayers a pearl necklace is stolen and hidden, but the ingenious hiding-place could only have been used for pearls. The theft occurs at a Christmas house-party, and must have been committed by one of the guests; the guests submit to being searched but no necklace is found. Reluctant to summon the police, the host suggests that possibly Lord Peter Wimsey (one of the guests) may be able to help. He agrees

and makes a thorough search of the two rooms which the party had used during the time when the theft was committed, finding a fine entomological pin which leads to the discovery of the pearls. The thief had cut the string and pinned the separated pearls into a bunch of mistletoe where they were unnoticed among the mistletoe berries. (This operation was carried out while the other guests were discussing the choice of an object for the game of Animal, Vegetable and Mineral: their deliberations must have been unusually prolonged.) Next day the host, prompted by Wimsey, announces that all the evergreens must be taken down and burned. The thief is discovered because, of course, he immediately insists upon taking charge of the mistletoe.

Fraud of a different kind is found in C. Rawson's story *From Another World*. An investigation is being made into the claims made by a medium with very strong psychic powers. It takes place in a sealed room with minimal furniture and the medium wears only a bathing-dress. Under these conditions she produces two shells, and these are identified as *Cochlostyla* sp. known only from the Philippines. This is regarded as a most impressive feat of long-range telekinesis, but the lady is unmasked as a regurgitating medium who had swallowed the shells previously.

More fraud involving shells occurs in *The Sands of Thyme*, a short story by Michael Innes. Appleby tells how, visiting a noted shell beach at Thyme Bay, he follows a single line of footprints and finds a body. There is a bullet-hole in the forehead, a revolver lying by it, and also a line of shells with a scrap of paper with the words "As a child I played with these for hours" – obviously a suicide. Later Appleby discovers that the dead man, a scientist at a nearby research station, was discovered stealing a secret file: he brought out a revolver and was shot during a struggle. To save his reputation his friends staged a suicide. The means adopted were complicated, involving the use of a helicopter, and the shells had nothing to do with the dead man – he had written the words found with the shells, but referred to paper gliders, and had been torn from his notebook. The whole scheme is totally incredible and Appleby finally admits that he had wanted to tell a story about "footprints in the sands of Thyme".

Thomas Mann's *Doctor Faustus* contains a charming chapter (to which Miss R. Holt drew my attention) in which the narrator, as a boy, visits his friend's father's farm. The farmer is interested in natural history and shows the children his illustrated books. Like many others he is fascinated by shell markings which look as though they were writing in some unknown script: they are compared with archaeological books in attempts to decipher them. There is no result, but he remains convinced that Nature produced the markings as a form of communication.

The works of J. R. R. Tolkien are much read and admired, but most readers have probably failed to notice the passive, fleeting, but crucial role played by a snail in *The Hobbit*. Bilbo the hobbit and a band of dwarves are on a mission to destroy Smaug the dragon who has usurped the dwarves' caves in the Lonely Mountain and laid waste the land. An old map shows a side entrance to the mountain, and secret writing says "Stand by the grey stone where the thrush knocks and the setting sun with the last light of Durin's Day will shine upon the keyhole". After many trials they reach the mountain but fail to find the door; at the last moment as the sun sinks a thrush flies down and cracks a snail upon a large stone. The last rays shine upon the key-hole as they stand by the stone and they are thus able to enter the mountain and finally bring about the death of the dragon.

T. E. Crowley observed that it was impossible to anthropomorphise a snail. It has, however, now been done. In *The Nautilus and the Gang of Three* J. K. Lee presents molluscs as world leaders holding a summit conference. The leaders are *Nautilus pompilius*, *Tridacna gigas*, *Lambis violacea* and *Turbinella pyrum*, each with a retinue of members of other species, and their peaceful meeting is to be held in the Indian Ocean. A hermit crab almost causes war by going from one to another spreading malicious gossip, and disguises himself cleverly by a

change of shell for each interview. War is averted by *Janthina janthina* who is alarmed by overhearing the villain. She enlists millions on *Janthina* to blanket the surface of the sea: it is then too dark for the other molluscs to be able to see to fight and they disperse in peace.

Since the Mollusca are, with the exception of the Cephalopoda, notably slow and retiring animals it is surprising that writers of fiction have contrived to make use of them in such a variety of roles. The following list is probably not exhaustive, but in addition to being part of the décor they have appeared as food, collectibles, pets, valuables, killers, clues (true and misleading), accessories to fraud, politicians, examples of mother-love, re-incarnation and objects of veneration. Some of the writers have made errors of fact and few would aspire to high literary standing, but at least they must be given credit for ingenuity.

BIBLIOGRAPHY

- ANON. 1831. *The Smuggler* Henry Collenson & Richard Bentley, London.
- CONAN DOYLE, A., 1985. *The Adventure of the Six Napoleons* in *The Further Adventures of Sherlock Holmes*. Omnibus ed.
- CROWLEY, T. E., 1975. Fictional Mollusca. *J. Conch.*, Lond., **28**: 61–74.
- ELIOT, G., 1872. *Middlemarch* 1985 Penguin Books, London.
- INNES, M., 1954. *The Sands of Thyme* in *Appleby Talking*. Victor Gollancz, London.
- JOHNSTON, G., 1850. *Introduction to Conchology*. Van Voorst, London.
- LEE, J. K., 1983. *The Nautilus and the Gang of Three*. Vantage Press, New York.
- MACDONALD, R., n.d. *The Pearl Lagoons or the Lost Chief*. C. W. Partridge & Co., London.
- MANN, T., 1947. *Doctor Faustus*. 1968 Penguin Books, London.
- MELVILLE, H., 1851. *Moby Dick*. 1946 The Cresset Press, London.
- RAWSON, C., 1981. *From Another World* in *All But Impossible*.
- SAYERS, D. L., 1933. *The Pearl Necklace* in *Hangman's Holiday* n.d. Laurance E. Spivack, New York.
- STEELE, F. A., 1887. *The Glory of the Sea* n.d. Religious Tract Society, London.
- STEINBECK, J., 1948. *The Pearl*. Wm. Heinemann, London.
- TOLKIEN, J. R. R., 1937. *The Hobbit*. George Allen & Unwin Ltd. London.
- VENNING, M. A., 1826. *Rudiments of Conchology*. 1837 Darton & Harvey, London.
- YONGE, C. M., 1856. *The Daisy Chain*. 1892 Macmillan & Co. London.
- , 1868. *The Chaplet of Pearls*. 1896 Macmillan & Co., London.
- , 1883. *Stray Pearls*. 1900 Macmillan & Co. London.

A RE-EVALUATION OF THE RECORDS OF *STHENOTEUTHIS PTEROPUS* (STEENSTRUP, 1855) (CEPHALOPODA: OMMASTREPHIDAE) FROM THE BRITISH ISLES

D. HEPPELL¹

(Accepted for publication, 15th February, 1992)

Abstract: Records of the squid *Sthenoteuthis pteropus* from British waters are reviewed in the light of current knowledge of its taxonomy and distribution. All extant material is re-identified as *Ommastrephes bartramii* on the basis of the tentacular fixing apparatus. This is consistent with the known distribution of the two species. It is concluded that all British records of *S. pteropus* are based on misidentifications.

INTRODUCTION

Identification of the species of squid from around the British Isles has been hampered by the lack of any comprehensive monograph. A Linnean Society *Synopsis* has been projected for at least 36 years, first by A. C. Stephen and then by W. J. Rees. After their deaths the task was taken up by Malcolm Clarke, but nothing has yet been published. The works of Pfeffer (1912), Grimpe (1925) and Jaeckel (1958), although still important, are difficult to use because the taxonomy is out of date and the synonymy is complex. Keys to families, genera and species and a modern taxonomy for all cephalopods are provided by Nesis (1987), but such a worldwide revision cannot include the detailed descriptions and illustrations required for a local fauna. Some of the two dozen or so species of squid on the British list (the most recent and complete list is by Smith & Heppell 1991) are only infrequent visitors to our waters. A few are known from no more than one or two captures or strandings. It is therefore not surprising that much uncertainty has surrounded the identity of some of the specimens recorded, especially the larger ones (i.e. those with a mantle length more than 50cm), as these are more likely to be found in a partly mutilated state, or are vandalized after stranding by souvenir hunters or bait collectors. They are also more difficult to preserve effectively and the cost of transporting the carcase to a permanent collection may be prohibitive.

Among the large squid which have occasionally been reported from the British area, mostly as stranded specimens, are the species of the subfamily Ommastrephinae of the family Ommastrephidae for which the generic names *Ommastrephes* and *Sthenoteuthis*, and the specific names *bartramii*, *caroli* and *pteropus* have variously been used. Currently the taxa *bartramii* and *pteropus* are assigned to the separate genera *Ommastrephes* and *Sthenoteuthis* respectively, while *caroli* is regarded as a junior synonym of *bartramii*. The interpretation of these names in relation to the status of the British records of the species correctly known as *Sthenoteuthis pteropus* (Steenstrup, 1855) will be discussed below.

¹ National Museums of Scotland, Chambers Street, Edinburgh EH1 1JF

LARGE SQUID, OTHER THAN OMMASTREPHIDAE, ON THE BRITISH LIST

Before considering the British Ommastrephidae in detail, mention may be made of the few other species with a mantle length exceeding 50cm which may be encountered in British seas.

Loligo vulgaris Lamarck, 1798, and ***L. forbesii*** Steenstrup, 1856 (Loliginidae).

These are the common neritic NE Atlantic and Mediterranean squid which are commercially fished. Although common, these squid are rarely stranded. Most specimens are too small to be classed as 'large squid', but *L. vulgaris* may reach 54cm mantle length and *L. forbesii* 75cm or, exceptionally, 90cm. The fins are rhomboidal, and not as wide as long. The Loliginidae is the only family of squid in British waters with a myopsid-type eye, in which the eye is covered with a transparent membrane punctured with a small anterior pore. In the remaining families of squid, the eyes are of oegopsid-type, being open and in contact with the sea-water.

Architeuthis dux Steenstrup, 1857 (Architeuthidae).

These are the giant squid, the largest of all invertebrates. The mantle length is commonly 100–200cm, but exceptionally may reach 500cm. The tentacles are extremely long, about 3–4 times the length of the mantle. In the Architeuthidae the fixing apparatus is comprised of scattered pairs of knobs and suckers along almost the entire length of the tentacles, and a large group of smooth-rimmed suckers and tubercles in the carpal area. The funnel-locking cartilage is straight and simple. The taxonomy of the genus is confused, but it is believed that other nominal species reported from the NE Atlantic (e.g. *A. monachus* Steenstrup, 1857, *A. princeps* Verrill, 1875, *A. harveyi* Verrill, 1879, *A. clarkei* Robson, 1933) are all synonyms of *A. dux*. Most specimens stranded on British shores are immature females, but mature males (of about the same size) have been captured in the North Sea. Specimens with a mantle length of <50cm are virtually unknown.

Galiteuthis armata Joubin, 1898 (Cranchiidae).

Adults of this oceanic species, which may reach a mantle length of 60cm, are most unlikely to be stranded as they are generally caught at depths between 500 and 2000m. The tentacle clubs are armed with hooks in the middle rows. *Taonidium pfefferi* Russell, 1909, is now believed to be a juvenile stage of this species which occurs at depths of less than 150m and has been recorded from the southwestern limits of the British area.

Another species, *Thysanoteuthis rhombus* Troschel, 1857 (Thysanoteuthidae), is included among the species listed by Smith & Heppell (1991) but, although it may occasionally stray into British waters, there are no definite locality records for it north of Madeira. Its long, broad, rhombic fins occupy the entire length of the mantle, which may reach a maximum length of 100cm.

TAXONOMY OF THE BRITISH OMMASTREPHIDAE

Squid of the family Ommastrephidae may be recognized by their heart-shaped or transversely rhomboidal fins and characteristic funnel cartilages with two deep grooves in the form of an inverted T. These are the 'flying squid'; their jet-propelled escape response often carrying them several metres through the air above the surface of the sea. The taxonomy of the British genera and species has long been confused. Three subfamilies are currently recognized: Illicinae, Todarodinae and Ommastrephinae.

In the older literature (e.g. Forbes & Hanley 1852, Jeffreys 1869) the generic name *Ommastrephes* Orbigny, 1835 (or its unjustified emendation *Ommatostrephes*) was used for all

the British ommastrephid squid. Forbes & Hanley (1852) included only three species, of which two were named *Ommastrephes sagittatus* (Lamarck) and *O. eblanae* (Ball). These correspond to our *Illex coindetii* (Verany, 1839) and *Todaropsis eblanae* (Ball, 1841) respectively. Jeffreys (1869) used the emended spelling *Ommatostrephes* for the generic name, and interpreted *O. sagittatus* in the same way as Forbes & Hanley, but complicated the situation by regarding Ball's *Loligo eblanae* as the female of *O. sagittatus*. The early confusion associated with the name *O. sagittatus* (Lamarck) is discussed below. The genera *Illex* Steenstrup, 1880, and *Todaropsis* Girard, 1890, were later separated off, distinguished among other characters by the lack of a specialized fixing apparatus. They are now assigned to the subfamily Illicinae, in which there are no enlarged teeth on the ring of the largest club suckers; photophores are absent; and the funnel groove is smooth, with no central pocket (foveola) or side pockets. *I. coindetii* should probably be regarded as a subspecies of the western Atlantic *I. illecebrosus* (Lesueur, 1821). Neither that species nor *Todaropsis eblanae* has a mantle length exceeding 35cm.

The original description of *Loligo sagittata* Lamarck, 1798, included two quite separate species: his var. A was our *Todarodes sagittatus*, but his var. B was our *O. bartramii* (Lesueur, 1821). As some French authors, however, identified Lamarck's var. B. with *I. coindetii*, it was inevitable that the name *sagittatus* was used in more than one sense by different authors. Hoyle (1902) discussed the identity of Lamarck's species, and concluded the name *sagittatus* should be used for the third species of ommastrephid squid included by Forbes & Hanley (1852) and Jeffreys (1869), which they had called *O. todarus* (delle Chiaje). As virtually all subsequent usage of the name has been in this sense, nomenclatural stability must favour Hoyle's interpretation whether or not it is technically sound.

The genus *Todarodes* Steenstrup, 1880, is now assigned to the subfamily Todarodinae, in which photophores are absent and the funnel groove has a foveola but no side pockets. The generic name *Sagittatus* Risso, 1826, was assumed to have priority over *Todarodes* by Winckworth (1951), and has been used in some recent lists (e.g. Seaward 1982, 1990). As *Todarodes* has enjoyed almost universal usage, and there is some evidence, moreover, which suggests that Risso's work was printed but never published, grounds for any change of generic name would seem to be quite insufficient. *Todarodes sagittatus* is the commonest of the large squid to be found stranded on British coasts. The mantle length is normally 30–40cm, but in large specimens may reach 60–65cm or even 75cm. The sucker-bearing portion of the tentacle is very long in this species (as in all members of the subfamily), comprising more than three-quarters of its length. The ring of the largest suckers on the tentacle club has only one, or sometimes two, strong teeth.

Former usage of the generic name *Ommastrephes* in the restricted sense was most often for the species *sagittatus*, with *Sthenoteuthis* Verrill, 1880 (or its unjustified emendation *Stenoteuthis*), being used for the larger forms named *bartramii*, *caroli* and *pteropus*. Other authors regarded these latter as the 'typical' *Ommastrephes*, and used the name *Todarodes* Steenstrup, 1880, for *sagittatus*. This latter interpretation is correct under the rules of nomenclature now accepted, as the type species of *Ommastrephes* is *O. bartramii*. *Sthenoteuthis* was then regarded as a junior synonym of *Ommastrephes*.

The type species of *Sthenoteuthis* is *Architeuthis megaptera* Verrill, 1878, originally described from near Cape Sable, Nova Scotia, much further north than *S. pteropus* would be expected to occur, though within the distribution limits of *O. bartramii*. Recently, however, Zuev *et al.* (1975) re-examined the holotype of *A. megaptera* and confirmed its synonymy with *S. pteropus*. They also demonstrated the close affinity between this Atlantic species and the tropical Indo-Pacific species *Symplectoteuthis oualaniensis* (Lesson, 1830), the type species of *Symplectoteuthis* Pfeffer, 1900. As the two type species are now congeneric, *Symplectoteuthis* becomes a junior synonym of *Sthenoteuthis*, and all three generic names, *Todarodes*, *Ommastrephes* and *Sthenoteuthis*, are currently in valid use.

The genera *Ommastrephes* and *Sthenoteuthis* are now assigned to the subfamily Ommastrephinae, distinguished by the presence of photophores, and a funnel groove with side pockets as well as a foveola. The ring of the largest suckers on the tentacle club has four large teeth; smaller teeth occur all round the ring. Until recently, two species of *Ommastrephes* were included in the British fauna, *O. bartramii* (Lesueur, 1821) and *O. caroli* Furtado, 1887. *O. caroli* was distinguished by greatly expanded triangular ventral membranes ('veils' or 'webs') on the third pair of arms. This feature is not of taxonomic importance, however, as it is a characteristic of large, female individuals. The synonymy of the two taxa was confirmed by Zuev *et al.* (1975).

THE TENTACLE CLUB IN THE OMMASTREPHIDAE

The structure of the arms and tentacles of squid reflect their different functions. The tentacles capture the prey, which is then held by the arms while being eaten. Suckers or hooks distributed over most of the length of the arms aid in securing the prey. The tentacles have an extensible stalk, usually devoid of suckers, which contracts to bring the captured prey within reach of the arms. Thus the length of the tentacle is not fixed, but depends on the amount of extension or contraction. The distal end is expanded to form the tentacle club.

The club in the Ommastrephidae bears oblique transverse rows of toothed suckers, and is divisible into three distinct portions: the carpus (= 'wrist'), the manus (= 'hand'), and the dactylus (= 'finger'). In the expanded manus the suckers are arranged in four longitudinal rows (quadriseiral), the two median rows having considerably larger suckers than the lateral rows. In the narrow terminal dactylus the suckers become considerably reduced in size, but are still arranged quadriseirally in all ommastrephids except *Illex* (which has 8 rows). The carpus has a few suckers, the arrangement of which is not so apparent as in the manus. In the subfamilies Todarodinae and Ommastrephinae (but not in the Illicinae) there is also in this area an arrangement of alternating suckers and tubercles (also known as 'knobs' or 'pads') along the dorsal edge of the club. The suckers of one club attach to the tubercles of the other, so that the tentacles may be joined along the proximal dorsal edge of the clubs. This ensures that during the rapid movement necessary for capturing prey, the two tentacles are extended to the same length and reach the prey at the same time. This interlocking system is known as the carpal structure, connective apparatus or fixing apparatus (FXA). Usually, from two to five tubercles occur on each club, but in some species of Todarodinae they may be poorly defined and obscure (Roeleveld 1982).

In the Todarodinae the FXA tubercles are grasped by toothed suckers, but in the Ommastrephinae the suckers of the FXA are normally modified as smooth-rimmed suckers. Although it was well known that the club structure, and especially the FXA, was an important taxonomic character in the Ommastrephidae, the analysis of the diagnostic features was imprecise because of difficulties in defining the limits of the carpal, manal and dactyl portions of the club, and in establishing the component suckers of a transverse row. The history of the different interpretations, and the problems of establishing a satisfactory baseline for comparison of specimens, has been ably reviewed by Roeleveld (1982). She proposed a new, and simpler, interpretation of club structure, which has been followed here, and showed that the FXA was far more regular than earlier work had suggested. In Roeleveld's system the first transverse row of the dactylus is taken to be that in which the ventrolateral sucker is equal to, or larger than the ventromedial, and the carpus is restricted to that portion of the club where the suckers form only two rows (biseiral). All quadriseirally arranged proximal suckers are thus considered part of the manus, even if they are subequal in size.

The structure of the tentacular club is not only of primary importance in defining the various families of squid, but it is also often diagnostic at the generic and specific levels as well. The proximal parts of the clubs of *O. bartramii* and *S. pteropus*, using Roeleveld's interpretation of the FXA, are illustrated in Figs. 1–4. These are based on Roeleveld's figures, but are here made more diagrammatic for easier comparison of the two species. The clubs of *O. bartramii* (Figs. 1–2) have the FXA placed more distally than those of *S. pteropus* (Figs. 3–4). There are normally three pairs of tubercles and smooth-rimmed suckers, though there may be only two in *O. bartramii* and as many as five in *S. pteropus*. Most commonly, the FXA begins with a sucker on the right club and with a tubercle on the left club. It is, in fact, the position of the first smooth-rimmed sucker, rather than that of the first tubercle, that is constant.

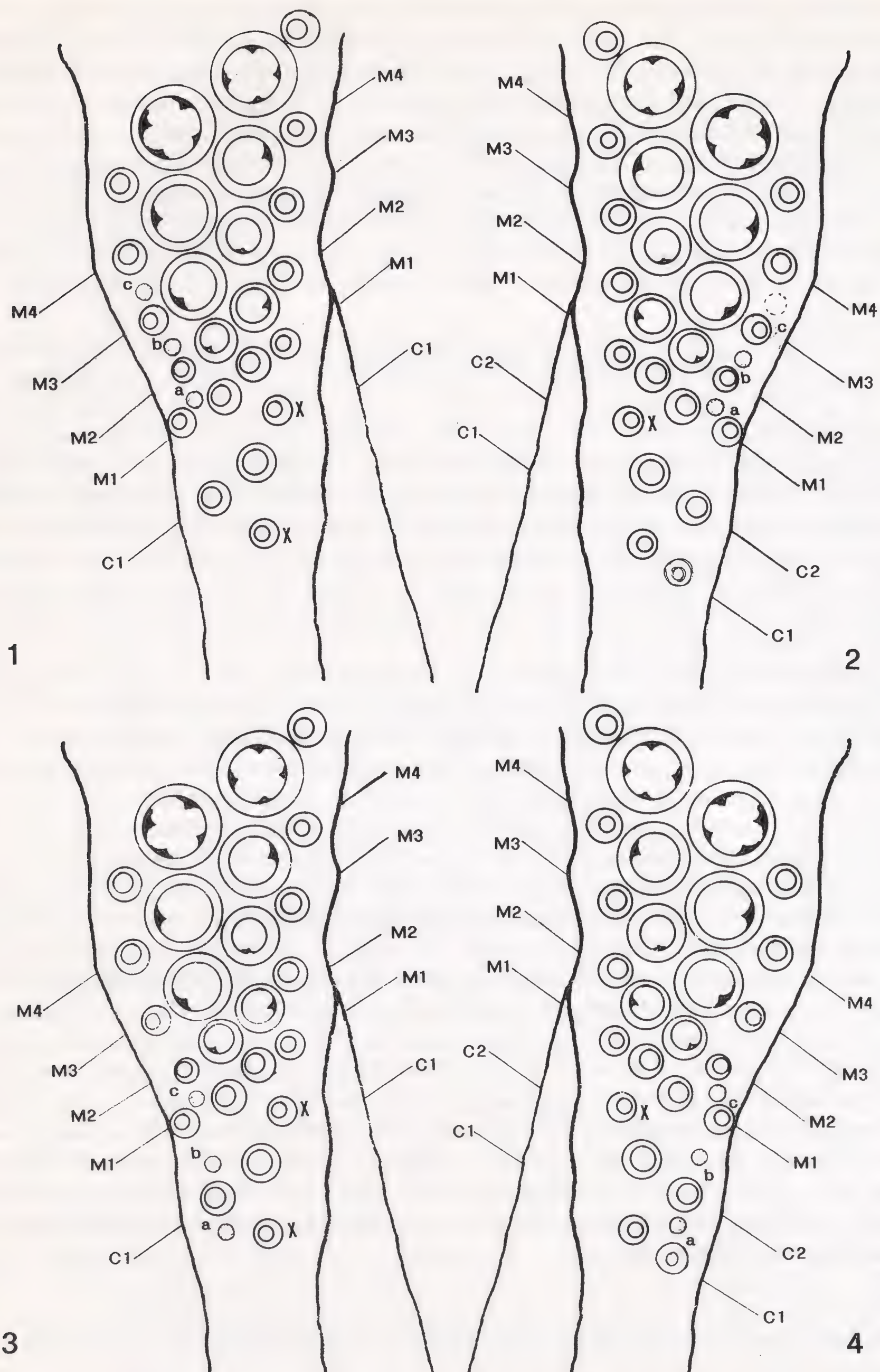
In the FXA of *O. bartramii* the first smooth-rimmed sucker of the left club is part of the second manus row, while on the right club it is the dorso-lateral sucker of the first manus row. All the smooth-rimmed suckers of the FXA are modified lateral manus suckers. The carpal suckers have teeth on the distal part of the rim and are not involved in the FXA. In *S. pteropus*, however, the dorso-lateral suckers of the carpal rows are smooth-rimmed and are part of the FXA, which extends into the manus only if more than one (left club) or two (right club) smooth-rimmed suckers are present. Thus there are two toothed suckers proximal to the FXA in the dorsal longitudinal column on both left and right clubs of *O. bartramii* and none in *S. pteropus*. Occasionally aberrant specimens of *S. pteropus* are found with supernumerary carpal suckers but, as they are invariably smooth-rimmed, these specimens cannot be confused with *O. bartramii*.

Steenstrup (1881) clearly described and illustrated the FXA of *O. bartramii* and *S. pteropus*, but was misled into thinking the development of the lateral membranes of the third arms an equally important character, leading him later to synonymize *O. caroli* with his *pteropus*, rather than with *bartramii*. One difficulty with the correct interpretation of *O. bartramii* is that the name was based on a small specimen, subsequently lost, from Newfoundland. It is almost certain, however, that Steenstrup's interpretation of the name was correct, and in any case his diagrams of the FXA show the two species as understood today. Nevertheless, when comparing the FXA of *O. caroli*, Steenstrup (1887), although noting the similarity to that of *O. bartramii*, accepted it as distinct because of the remarkable 'veils' on the third pair of arms.

A further morphological character, often cited as a means of distinguishing between *S. pteropus* and *O. bartramii*, is the relative length of the fourth pair of arms. In *S. pteropus* the fourth pair of arms is usually the longest, whereas that pair is generally not as long as the second and third pairs in *O. bartramii*. In preserved material, however, the extremities of the arms may be lost, and differential shrinkage of the arms makes this character unreliable, as the difference between the species is in any case not great. Although measurements of the arms were taken in the course of this survey, and the fourth pair of arms was indeed the longest in two of the specimens examined (nos. 7 and 14 in the list below), this was not considered significant; the identifications were confirmed on the basis of the arrangement of the FXA whenever possible.

DISTRIBUTION OF *STHENOTEUTHIS PTEROPUS* AND *OMMASTREPHES BARTRAMII*

Following Steenstrup (1887), specimens stranded on the European shores were generally identified as *O. caroli* if they exhibited well-developed veils. Other specimens were usually attributed to *O. pteropus*, partly on the assumption that (only) two species occurred in the area, and partly by comparison with previously misidentified material. The possibility of three species of ommastrephine squid being present in European waters survived until



Figs. 1-4. Diagrams of the proximal portions of the tentacle clubs of *Ommastrephes bartramii* and *Sthenoteuthis pteropus*, according to Roeleveld's interpretation of the club structure. 1-2. *O. bartramii*, left and right clubs; 3-4. *S. pteropus*, left and right clubs. C1, C2 First and second carpal rows of suckers; M1, M2, M3, M4 First to fourth manus rows of suckers; X Odd carpal suckers, not included in the row count; a, b, c. The FXA consisting normally of three pairs of tubercles and smooth-rimmed suckers; the position of the distal tubercle of the right club is indicated, but is not always present.

comparatively recently. Clarke (1965) stated that three species of the genus *Ommastrephes*, *O. caroli*, *O. pteropus* and *O. bartramii*, are found in the North Atlantic. He mentioned "the taxonomic controversy surrounding these species since their description", and noted that "criteria for separating the three species at all stages have not yet been clearly established". Using the identification criteria accepted at that time, Clarke studied several hundred specimens from an area extending from the English Channel to the Canary Islands. He concluded that whereas *O. bartramii* and *O. caroli* were present throughout the area, *O. pteropus* occurred only in waters south of Madeira, its limits being the 22°C isotherm. Only medium-sized females (mantle length 25–38cm) of that species were present in the population of the eastern North Atlantic. The most important outcome of Clarke's investigation was to show that the large photogenic organ on the dorsal surface of the mantle, just posterior to the neck, which was known to be characteristic of these females, was in fact a character of taxonomic value for recognizing *Sthenoteuthis pteropus*, as males and young females from the Caribbean also possessed this organ. A full description of the dorsal photogenic organ is given in Clarke's paper; it is clearly detectable in dead specimens as an oval-shaped mark, and may be exposed by removing the overlying skin.

The details of the population structure of *S. pteropus* are given by Zuev *et al.* (1976). For the equatorial and inter-tradewind populations, the areas of feeding and reproduction coincide, and individuals of those populations do not make significant migrations. In peripheral populations, however, although they reproduce exclusively in low latitudes, the fringe regions of their distribution are used only for feeding by the sexually immature individuals, almost without exception females, and small individuals of this species are rare in such zones. Similarly *O. bartramii* is basically a subtropical species in the Atlantic, but in the main feeding period it also spreads into the colder waters of the North Atlantic and Mediterranean as far north as the Faroes. Thus, to the shores of the British Isles and the North Sea come only large, though not yet mature, females, for the most part in autumn and winter (Rees 1950). These are the specimens which were identified as *O. caroli*. In fact the distributions of *O. bartramii* and *S. pteropus* are almost completely separate, and in the North Atlantic principally overlap between Madeira and Cap Blanc, although distribution boundaries change with seasonal variation in water temperature.

BRITISH RECORDS OF *STHENOTEUTHIS PTEROPUS*

Although the normal distribution of *S. pteropus* does not extend north of Madeira, this does not preclude the possibility of occasional rare stragglers occurring outside their normal range and reaching British shores. The type locality of the synonymous species *Architeuthis megaptera* is, after all, off eastern Canada. It was possible that at least some of the records had been correctly identified. Steenstrup (1881) had provided adequate diagnostic characters for the discrimination of *O. bartramii* and *S. pteropus* and, although the key given by Hoyle (1902) was misleading, the figures and keys provided by Pfeffer (1908, 1912), Grimpe (1925), Jaeckel (1958) and Muus (1959), among others, were accurate and workable, not only regarding the disposition of the FXA elements, but also in such characters as the relative lengths of the third and fourth arms. Was their information about *S. pteropus* based entirely on non-European material (Steenstrup's holotype was from St Croix, in the Caribbean), or were some of their recorded British localities for that species genuine? In an attempt to answer this question, all the evidence for records of the species from the British Isles has been reviewed as far as possible.

The first British records of these large Ommastrephinae are by Goodrich (1892), who gave details of a specimen captured off Salcombe, Devon, and identified as *O. pteropus*. He

also noted two others from the North Sea. Clarke & Robson (1929) listed records of large squid stranded on the north-east coast of England and for the first time reviewed previous records from other parts of the British Isles. They included ten records (one doubtful) of *S. pteropus* and a further two recorded as either *S. pteropus* or *S. caroli*. Rees (1950) plotted all known records of *Ommastrephes* on the British coasts, and observed that, with the exception of the specimen recorded from North Berwick as *S. pteropus* by Ritchie (1922), all strandings had occurred during the winter months from November to March. His explanation was that these are oceanic squid which occasionally migrate into the North Sea, possibly during the summer months, and are later enfeebled by unfavourable conditions such as lack of suitable food, lower salinity and temperature fluctuations. In fact the date of Ritchie's North Berwick stranding was not anomalous, but had been recorded erroneously (as 'June 1921') by Stephen (1944); the correct date, 13 January 1921, is given by Heppell & Smith (1983). Altogether Rees listed 26 strandings of *O. caroli* and ten of *O. pteropus*. Seaward (1982) included five records (all pre-1951) of *O. pteropus* and 11 records (2 post-1951) of *O. caroli*, but notes that the records of *O. pteropus* are probably based on juvenile *O. caroli*. More recently, Seaward (1990) transferred all the British records of *O. pteropus* to *O. caroli*, whereas Smith & Heppell (1991) include only *O. bartramii* in the most recent checklist of British marine Mollusca.

Heppell & Smith (1983) re-examined a number of specimens previously identified as *S. pteropus* and confirmed their identity with *O. bartramii*, but the remaining British records seem to have been changed merely on the assumption that *S. pteropus* never occurs in the British area, based on recent revisions of ommastrephid taxonomy and distribution (Clarke 1965, 1966, Zuev *et al.* 1975, 1976). As a number of exotic species are known occasionally to stray beyond their normal distribution range and onto our shores (the leathery turtle, the beluga, the walrus and the giant squid *Architeuthis* are probably all examples of such strays), it seemed advisable to review the evidence for all known records of *S. pteropus* before finally striking it from the British list.

The records are listed here in chronological order. The primary sources of the records are given, and additional information is included from secondary sources for some specimens. Reference to Ritchie MS. is to archival material in the Department of Natural History, National Museums of Scotland. Dimensions are given in the units of the original account, except that feet and inches are converted to inches, and millimetres to centimetres. Dimensions in parentheses have been converted from inches to centimetres (or *vice versa*), to the nearest 0.5in or 0.5cm, for ease of comparing data. Only a selection of the measurements recorded are included here.

1. 19 November 1883. Scarborough, Yorkshire (Goodrich 1892).

An incomplete specimen. Length 52in (132cm), including the arms. Goodrich stated, on the authority of E. A. Smith, that this specimen is in the Natural History Museum, London, but Gill (1911) indicated that it was probably no longer extant. As it cannot now be found, its identity cannot be positively ascertained.

2. 27 February 1884. North Sea (Goodrich 1892).

A perfect specimen. Length 39in (99cm) from tip of tail to mouth; tentacles 36in (91.5cm). Said by Goodrich to be in the Natural History Museum, London, but the specimen does not appear to have been kept, and its identity must remain uncertain. It was not included among the extant specimens noted by Gill (1911).

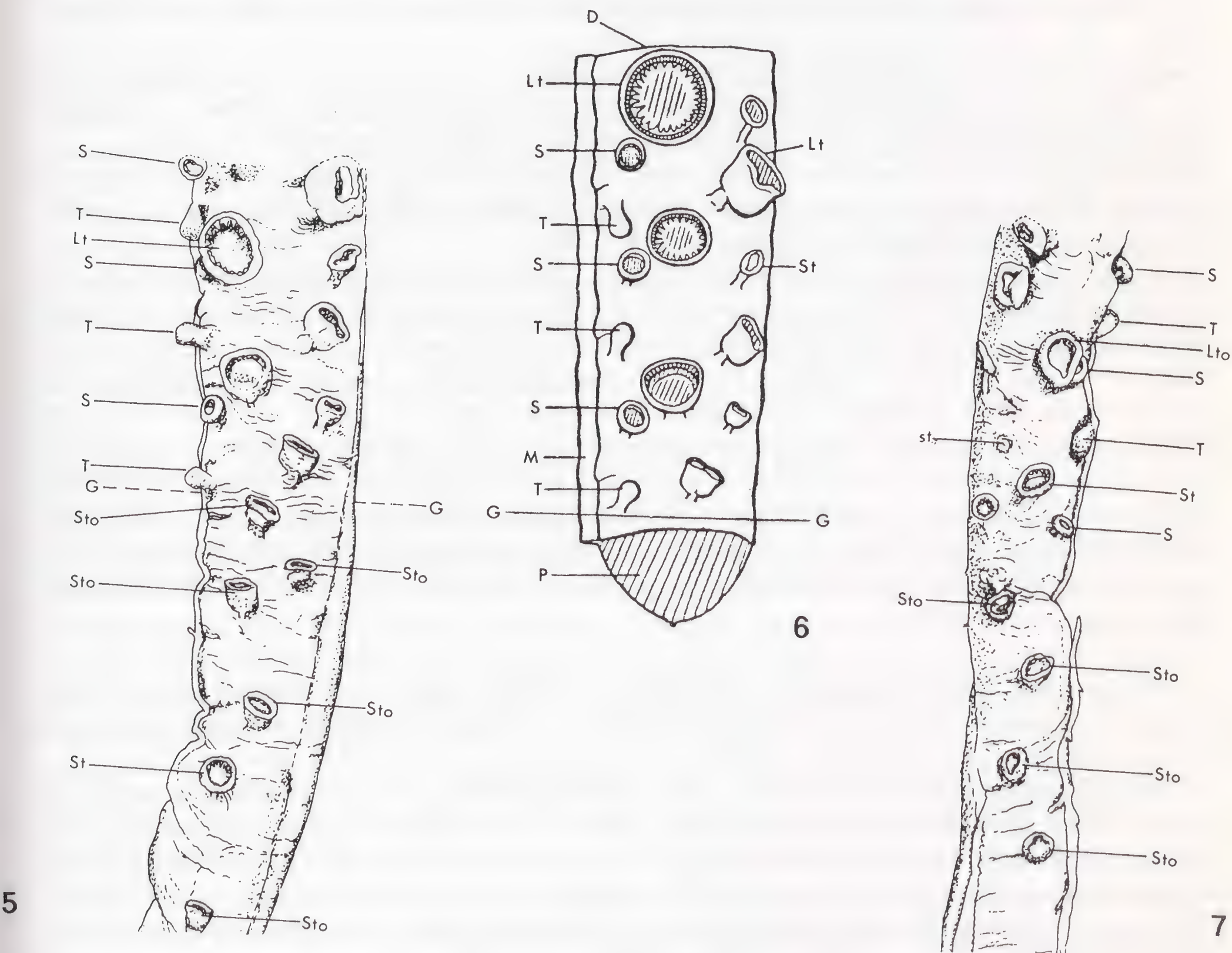
3. 6 January 1892. Off Salcombe, Devon (Goodrich 1892).

Female, "in very fair condition". Dimensions (after preservation in chromic acid and alcohol): dorsal mantle length 51cm (20in); ventral mantle length 50cm (19.5in); length

from tip of tail to mouth 66cm (26in); 3rd arms 28.5cm (11in); 4th arms 28cm (11in); tentacles 64cm (25in).

Presented to the Marine Biological Association, Plymouth, by Dr Elliot of Kingsbridge, Devon. Subsequently purchased for the Oxford University Museum by Prof. Ray Lankester (Reg. No. 5313).

I have examined this specimen, compared it with Goodrich's description, and made a series of photographs including details of the two tentacle clubs. From the photographs, drawings were made of the proximal ends of the left and right clubs (Figs. 5, 7) for comparison with Goodrich's own figures. This revealed the reason for the continued misidentification of this specimen. Goodrich had stated that "the arrangement of these suckers and tubercles is similar to that described and figured by Steenstrup for *O. pteropus*" and, furthermore, had given a good figure of part of the left tentacle club (his Fig. 3), showing the FXA comprised of three pairs of tubercles and smooth-rimmed suckers, with no further suckers shown proximally. If this had indeed been the complete proximal end of the club, the identification as *S. pteropus* would have been confirmed. Unfortunately, Goodrich did not



Figs. 5–7. The proximal portion of the tentacle club of the Salcombe specimen (3) of *Ommastrephes bartramii*. 5. Left club. 6. Goodrich's original figure of the same club, enlarged to the same scale and re-lettered for comparison. The suckers proximal to the FXA were omitted by Goodrich. 7. Right club.

D Distal cut surface; G–G Proximal limit of FXA; Lt Large toothed sucker; Lto Large toothed sucker from which the teeth have been lost; P proximal cut surface; S Smooth-rimmed sucker, part of the FXA; st Stalk of small toothed sucker, remainder of sucker lost; St Small toothed sucker; Sto Small toothed sucker from which the teeth have been lost; T Tubercle, part of the FXA.

mention that a further six toothed suckers were present proximal to the portion shown in his figure (see Fig. 6). The specimen is, in fact, a typical example of *O. bartramii*. On the right club there are the usual five toothed suckers proximal to the FXA.

4. "Many years ago". Killala, Co Mayo, Ireland (Nichols 1905).

Specimen consists only of the left tentacle club, deposited in the National Museum of Ireland, Dublin. Nichols states that there are four tubercles on this club (compared with two on the clubs of the following specimen), but "from the arrangement and structure of the suckers" Nichols believed this to be the same species (i.e. *pteropus*) as the Miltown Malbay specimen. Unfortunately, the number of tubercles involved in the FXA varies, and is not in itself a taxonomic character for discriminating between *pteropus* and *bartramii*. The significant detail, of which Nichols was probably unaware as it seems not to have been noted before Pfeffer (1912), is the number of suckers proximal to the most proximal tubercle (0–2 in *S. pteropus*; 5–6 in *O. bartramii*).

5. "A few years ago". Cast on the shore at Miltown Malbay, Co Clare, Ireland (Nichols 1905).

Assumed to be a female; slightly damaged, the head having been detached from the mantle, and some of the internal organs missing. Dimensions (before preservation in alcohol): mantle length 66cm (26in); 3rd (longest) arms 38cm (15in); tentacles 99cm (39in).

Specimen presented to the National Museum of Ireland, Dublin, by Mrs Morny of Miltown Malbay. Neither this, nor the previous specimens, were noted in the list of Irish marine Mollusca published five years earlier (Nichols 1900).

Nichols (1905) gave an outline drawing of the dorsal view of this specimen, which places identity as an ommastrephid squid beyond doubt. Unfortunately, the reduction to one-tenth natural size does not allow the detail of the suckers and FXA of the carpal area of the tentacle clubs to be made out. At first glance the figure appears to show suckers extending along the tentacle stalk, as in *Todarodes*, but these marks, according to the text, represent fourteen transverse ridges, as in the Salcombe specimen (3) above. Nichols based his determination of this specimen on the key provided by Hoyle (1902) and, even though the number of tubercles (two) in the FXA might have led him to identify it as *bartramii*, he seems to have been more influenced by the overall size of the specimen and the length of the tentacles relative to the arms. In fact, both the size and proportions of this specimen are very similar to the following one.

6. 19 December 1907. Redcar, Yorkshire (Hoyle 1908, Hargreaves 1910, Stevenson 1935). Clarke & Robson (1929) noted that this specimen is stated by Hoyle to come from both Redcar and Scarborough, but the Redcar locality is obviously the correct one.

Total length 70.5in (179cm), with the tentacles extended. Hoyle included a photograph of the dorsal view of the intact animal. The specimen "was allowed to decompose and was buried before any naturalist had an opportunity of examining it". Subsequently, "the remains were exhumed and a portion of one of the tentacles with most of its suckers intact, the buccal mass with the mandibles, and some fragments of the pen rendered it possible to identify the animal as a specimen of *Sthenoteuthis pteropus*".

From Hoyle's photograph the specimen is clearly an ommastrephine squid, without suckers on the tentacle stalks. The details of the FXA cannot be made out, but the photograph is clear enough to have shown a dorsal light organ if one had been present and, in its absence, it may be safely concluded that this was a specimen of *Ommastrephes bartramii*.

Hargreaves (1910) also included a record from Grinstead, but gave no further details. This record has not been noted by later workers.

7. 8 January 1911. Washed up at the mouth of the **Briar Dene**, on the sandy beach between Whitley Bay and St Mary's Island, Northumberland (Gill 1911, Meek & Goddard 1926; Clarke & Robson 1929).

An almost perfect specimen: "Though dead it was quite fresh, and the only damage it had suffered was the loss of one eye." Dimensions before preservation: total length 66.5in (169cm); tip of tail to mouth 33.5in (85cm); tentacles 36in (91.5cm). Dimensions after preservation: total length 57in (145cm); dorsal mantle length 65.0cm (25.5in); tip of tail to tip of longest arm 47in (119.5cm); tip of tail to tip of first arm 44in (112cm); 3rd arms 35.2cm (14in); 4th arms 37.5cm (15in); tentacles, right 73.0cm (28.5in), left 66.7cm (26in). A photograph of this specimen before preservation is in the Ritchie MS. Presented to the Hancock Museum, Newcastle, by Hugh V. Charlton. Re-determined as *O. caroli* by Meek & Goddard (1926). Subsequently presented by the Hancock Museum to the Natural History Museum, London, 8 March 1965 (Reg. No. 1965377W).

Meek & Goddard (1926) examined this specimen in detail for comparison with the Cullercoats specimen (11). They realised the inadequacy of some of the taxonomic characters in use at that time, as the specimens exhibited some features supposed to be characteristic of *pteropus* and others of *bartramii* and *caroli*. They concluded that it came nearest to *caroli*, but admitted "there should not be this uncertainty in the case of an almost perfect specimen". The diagnoses of these taxa were evidently based on characters liable to individual variation. Meek & Goddard's plate of the specimen shows the ventral view; it is not clear enough to be sure but at least five suckers appear to extend some way proximal to the FXA.

I have examined this specimen and photographed the proximal portions of the left and right tentacle clubs. There are well-developed veils on the third arms. The FXA is comprised of four tubercles and three smooth-rimmed suckers on the left manus, and three tubercles and four smooth-rimmed suckers on the right manus. All elements of the FXA are part of the manus series, with the carpal suckers proximal to them, and thus the identity of the specimen is confirmed as *O. bartramii*.

8. 1 March 1912. **Redcliff**, near Scarborough, Yorkshire (Clarke & Robson 1929, Stevenson 1935).

A somewhat mutilated, skinless specimen. Length 36in (91.5cm), not including tentacles. Received by Clarke, who photographed it. This photograph was reproduced by Stevenson (1935: pl. 6, fig. 2). It shows the dorso-lateral view, but is too small for details to be made out, though there is no obvious dorsal photophore. The specimen was eventually deposited in the National Museum of Wales. This appears to be the specimen purchased from Hargreaves of Scarborough for 4s 6d on 25 March 1912 (NMW Reg. No. 1912.24). This specimen was found to be missing from the collections in 1936 and does not now appear to be extant.

9. 13 January 1921. West Bay, **North Berwick**, East Lothian (Ritchie 1922, Stephen 1944). Claimed to be the first Scottish record. "Very much alive when stranded". Dimensions: mantle length 33.75in (85.5cm); longest arm 17.5in (44.5cm); tentacles 39in (99cm) (Ritchie MS.). Photographs in Ritchie MS. Deposited in Royal Scottish Museum [now National Museums of Scotland] by W. M. Ingles (Reg. No. NMSZ 1921.30). Dissected and preserved after a complete cast made for display (NMSZ 1921.95). Determined as *O. bartramii* by Heppell & Smith (1983:36).

10. January 1921. West coast of Scotland (i.e. near **Portree**, Isle of Skye) (Ritchie 1922, Stephen 1944).

The specimen was complete when stranded. Dimensions (from Ritchie MS.): total length c. 60in (152.5cm); mantle length 63cm (25in).

Details of this specimen are given in a letter dated 14 February 1921 from J. H. Ashworth to Ritchie (Ritchie MS.). Ashworth's information was from John A. Inglis, a science teacher at Portree, by letter of 1 February 1921. The specimen had been lying on the shore near Portree for three weeks, and was not by then in good condition. Those who first saw it "believed it came off a trawler, having been entangled in the nets". The trawlers, in the harbour for shelter, "were cleaning their nets and were not local . . . a day or two after this the squid was observed on the shore". Inglis sketched and measured the carcase, and forwarded the head, arms and tentacles to Ritchie for examination. These are now in the collections of the National Museums of Scotland (Reg. No. NMSZ 1978030.1). Determined as *O. bartramii* by Heppell & Smith (1983).

Another specimen cast up on Vallay, North Uist, in 1920, was recorded as *Sthenoteuthis* sp. in the Ritchie MS. It was not noted by Stephen (1944) or Rees (1950), and no material appears to have been preserved.

11. 7 January 1925. Washed ashore at **Cullercoats**, Northumberland (Meek & Goddard 1926).

Dimensions: dorsal mantle length 62.9cm (25in); 3rd arms 34.3cm+ (13.5in); 4th arms 36.8cm+ (14.5in); tail to tip of arms 111.8cm (44in). Left 4th arm the only one complete to the tip. Tentacles reduced to short stumps, only a few centimetres in length. The accompanying photograph shows the dorsal view of the specimen; there is no light organ visible on the back.

Presented to the Dove Marine Laboratory, Cullercoats by R. Smith. Preserved in formalin. Subsequently transferred to the Zoology Department of Armstrong College, Newcastle, for further examination.

Meek & Goddard attempted to identify this specimen using Pfeffer's (1912) descriptions, but the absence of tentacles and the unusual condition of the funnel groove (which was quite unlike anything previously described) made satisfactory determination impossible. It was then compared with the Briar Dene specimen (7), but that specimen too appeared to have characters of more than one species. Despite the very detailed description of the funnel groove and other anatomical features, it is not possible to be absolutely certain of the identification in the absence of the tentacles. The fact that the veils of the third arm were well developed certainly suggests it was a female *O. bartramii*. Determined as *O. pteropus* or *O. caroli* by Clarke & Robson (1929), and as *O. caroli* by Rees (1950).

12. September 1925. Trawled off **St Kilda** in 180–200 fathoms (329–366m) (Rees 1950). Female. Total length 72in (183cm), according to Rees. This is probably its length before preservation. The specimen is difficult to measure accurately (apart from the mantle length) as the body is distorted, owing to poor preservation, with the mouth and arms fixed towards the ventral side. The measurements made when I examined the specimen are: total length c. 142cm (56in); dorsal mantle length 56cm (22in); tip of tail to tip of first arm c. 91.5cm (36in).

Presented to the Natural History Museum, London, by R. J. Daniel (Reg. No. 1925.10.27.1). A note has been added to the specimen label: "This is not *O. pteropus* but *O. bartramii* or *O. caroli* – M Roeleveld, 27 October 1977".

I photographed the manus of each tentacle club. The left tentacle is rotted and detached. The FXA confirms the identity of the specimen as *O. bartramii*. The dorso-lateral sucker of the first manus row is missing on both clubs. There are four fixing tubercles on the left manus and three on the right.

13. 1926. Off the **Isle of Man** (Clarke & Robson 1929, Rees 1950).

Radula only sent to Robson by H. C. Chadwick. Clarke & Robson comment that it would

seem to be referable to *Sthenoteuthis*, but it “is not readily to be identified as that of any of our three north-east Atlantic species, though it resembles that of *S. pteropus*”. The radula has not subsequently been examined (if, indeed, it is still extant), and it is unlikely to prove a satisfactory means of positive identification, as radulae are highly variable even amongst individuals of one species.

14. 10 February 1928. **Dunvegan**, Isle of Skye (Ritchie MS.).

Identified as *S. pteropus* in Ritchie MS., but not included by Stephen (1944).

Dimensions: mantle length 24in (61cm); tip of tail to tip of arms 42.5in (108cm); 3rd arm 12.5in (32cm); 4th arm 13.5in (34cm); tentacles 27.5in (70cm).

Presented by J. Mackenzie. “The specimen was too decomposed to be of any use for mounting whole, but we kept parts of it” (Ritchie MS.). Arm, right tentacle and some other parts in the collections of the National Museums of Scotland (see Heppell & Smith, 1983, for details), (Reg. no. NMSZ 1977107.3). Determined as *O. bartramii* by Heppell & Smith, 1983.

CONCLUSIONS

The status of fourteen records of *Sthenoteuthis pteropus* from the British Isles was reviewed from extant specimens and published data. It was concluded that all material examined was in fact of *Ommastrephes bartramii*, and nothing in the accounts of other specimens led to the supposition that other species were involved. This is in keeping with current understanding of the distribution of the two species.

The older material had been misidentified because of the deficiencies of the keys available, in which characters were based on variable factors. Although some of the records have subsequently been referred to as *O. bartramii* (or its synonym *O. caroli*), belief in British localities for *S. pteropus* had been maintained especially by the Salcombe (3) and North Berwick (9) specimens. The first of these was misinterpreted because of a misleading figure accompanying its description. Consequently, later authors, who provided correct figures of the NE Atlantic Ommastrephidae (and reasonable keys to the species), nevertheless included erroneous locality data based on these misidentifications. There are in fact no British records of *Sthenoteuthis pteropus*.

ACKNOWLEDGEMENTS

I should like to thank Martina Roeleveld for valuable discussion of the tentacular club structure of several specimens, especially of Goodrich’s specimen from Salcombe, and Aldyth Cadoux for translating the two papers by Zuev *et al.* I am also grateful to Mark Shaw and to the anonymous referee for suggesting several improvements to the presentation of this paper.

REFERENCES

- CLARKE, M. R., 1965. Large light organs on the dorsal surfaces of the squids, *Ommastrephes pteropus*, “*Symplectoteuthis oualaniensis*” and “*Dosidicus gigas*”. *Proc. malac. Soc. Lond.* **36**: 319–321.
 ———, 1966. A review of the systematics and ecology of oceanic squids. *Adv. mar. Biol.* **4**: 91–300.
 CLARKE, W. J. & ROBSON, G. C., 1929. Notes on the stranding of giant squids on the north-east coast of England. *Proc. malac. Soc. Lond.* **18**: 154–158.

- FORBES, E. & HANLEY, S., 1852. *A History of British Mollusca and their Shells*. Vol. 4, part 48. Van Voorst, London.
- GILL, E. L., 1911. A large squid on the Northumberland coast. *Zoologist, Lond.* **15**: 117–118.
- GOODRICH, E. S., 1892. Note on a large squid (*Ommastrephes pteropus* Steenstrup). *J. mar. biol. Ass. U.K. (N.S.)* **2**: 314–321.
- GRIMPE, G., 1925. Zur Kenntnis der Cephalopodenfauna der Nordsee. *Wiss. Meeresunters. (N.F.) (Helgoland)* **16** (1) No. 3.
- HARGREAVES, J. A., 1910. The marine Mollusca of the Yorkshire coast and the Dogger Bank (concluded). *J. Conch., Lond.* **13**: 99–105.
- HEPPELL, D. & SMITH, S. M., 1983. Recent Cephalopoda in the collections of the Royal Scottish Museum, Edinburgh. *Inf. Ser. R. Scott. Mus. (Nat. Hist.)* **10**.
- HOYLE, W. E., 1902. British Cephalopoda: their nomenclature and identification. *J. Conch., Lond.* **10**: 197–206.
- , 1908. A large squid at Redcar. *Naturalist* No. 615: 132–133.
- JAECKEL, S., 1958. Cephalopoden. *Tierwelt N.-u. Ostsee*. **9b₃** [Lieferung 37].
- JEFFREYS, J. G., 1869. *British Conchology*. Vol. 5. Van Voorst, London.
- MEEK, A. & GODDARD, T. R., 1926. On two specimens of giant squid stranded on the Northumberland coast. *Trans. nat. Hist. Soc. Northumb. (N.S.)* **6**: 229–237.
- MUUS, B. J., 1959. Skallus, søtænder, blæksprutter. *Danm. Fauna*. **65**.
- NESIS, K. N., 1987. *Cephalopods of the World*. T.F.H. Publications, Neptune City, NJ. [A revised English edition of Nesis, K. N., 1982. *Kratkiy opredelitel' golovonogikh molluskov Mirovogo okeana*. Moscow.]
- NICHOLS, A. R., 1900. A list of the marine Mollusca of Ireland. *Proc. R. Ir. Acad. (3)* **5**: 477–662.
- , 1905. On some Irish specimens of a large squid, *Sthenoteuthis pteropus* (Steenstrup). *Ir. Nat.* **14**: 54–57.
- PFEFFER, G., 1908. Cephalopoden. *Nord. Plankt.* **4**: 9–116 [Lieferung 9].
- , 1912. Die Cephalopoden der Plankton-Expedition. *Ergebn. Plankton-Exped.* **2**.
- REES, W. J. 1950. On a giant squid, *Ommastrephes caroli* Furtado stranded at Looe, Cornwall. *Bull. Br Mus. nat. Hist. (Zool.)* **1**: 31–41.
- RITCHIE, J., 1922. Giant squids on the Scottish coast. *Rep. Br. Ass. Advmt Sci.* **89** (1921): 423.
- ROELEVELD, M. A., 1982. Interpretation of tentacular club structure in *Sthenoteuthis oualaniensis* (Lesson, 1830) and *Ommastrephes bartramii* (Lesueur, 1821) (Cephalopoda, Ommastrephidae). *Ann. S. Afr. Mus.* **89**: 249–264.
- SEAWARD, D., 1982. *Sea area Atlas of the marine molluscs of Britain and Ireland*. Nature Conservancy Council, Shrewsbury.
- , 1990. *Distribution of the marine molluscs of north west Europe*. Nature Conservancy Council, Peterborough.
- SMITH, S. M. & HEPPELL, D., 1991. Checklist of British marine Mollusca. *Inf. Ser. natn. Mus. Scotl.* **11**.
- STEENSTRUP, J., 1881. Orientering i de Ommastrephagtige blæksprutters indbyrdes forhold. *Overs. K. danske Vidensk. Selsk. Forh.* **1880–81**: 73–110.
- , 1887. Notae teuthologicae, 8. *Overs. K. danske Vidensk. Selsk. Forh.* **1887**: 128–146.
- STEPHEN, A. C., 1944. The Cephalopoda of Scottish and adjacent waters. *Trans. R. Soc. Edinb.* **61**: 247–270.
- STEVENSON, J. A. 1935. The cephalopods of the Yorkshire coast. *J. Conch., Lond.*, **20**: 102–116.
- WINCKWORTH, R., 1951. A list of the marine Mollusca of the British Isles: additions and corrections. *J. Conch., Lond.*, **23**: 131–134.
- ZUEV, G. V., NESIS, K. N. & NIGMATULLIN, C. M., 1975. Sistema i evolyutsiya rodov *Ommastrephes* i *Symplectoteuthis* (Cephalopoda, Ommastrephidae). [System and evolution of the genera *Ommastrephes* and *Symplectoteuthis* (Cephalopoda, Ommastrephidae)]. *Zool. Zh.* **54**: 1468–1479.
- , 1976. Rasprostranenie rodov *Ommastrephes* d'Orbigny, 1835, *Sthenoteuthis* Verrill, 1880 i *Todarodes* Steenstrup, 1880 (Cephalopoda, Oegopsida) v Atlanticheskom okeane. [Distribution of the genera *Ommastrephes* d'Orbigny, 1835, *Sthenoteuthis* Verrill, 1880 and *Todarodes* Steenstrup, 1880 (Cephalopoda, Oegopsida) in the Atlantic Ocean]. *Byull. Mosk. Obshch. Ispyt. Prir. (Biol.)* **81** (4): 53–63.

PARVICARDIUM HAUNIENSE, AN ENDEMIC SPECIES TO BALTIC BRACKISH WATER, NEW TO THE MEDITERRANEAN REGION

M. WOŁOWICZ¹

(Accepted for publication, 15th February, 1992)

Abstract: *Parvicardium hauniense*, a small brackish water bivalve living in the Baltic Sea and considered an endemic species for this sea, was recorded in the étang du Thau (Gulf of Lion, S. France). The ecological conditions in this étang are very different from those known from the Baltic Sea. The occurrence of *P. hauniense* in the Mediterranean basin suggests wide adaptation possibilities to environmental factors. Because of its occurrence in the Mediterranean basin its presence in other brackish water areas of the European coasts, as in the case of *Cerastoderma glaucum*, cannot be excluded.

INTRODUCTION

The small bivalve *Parvicardium hauniense* described by G. Høpner Petersen & P. J. C. Russell (1971a) from Dybso Fiord was previously incorrectly identified as *Cardium exiguum* (Gmelin). The validity of *P. hauniense* as a separate species has been confirmed by electrophoresis of malic acid (Jelnes *et al.* 1971), as well as by six other isoenzymes (Wołowicz, unpublished). Until recently the species was considered endemic to the Baltic (Petersen & Russell 1971a) because of its very narrow geographical distribution in the Central and Western Baltic (from the south-eastern part of the Danish waters to the Aland Islands) (Petersen & Russell 1971b, 1973, Russell & Petersen 1973, Wołowicz 1977, 1987a). In autumn 1990 *P. hauniense* was recorded in the étang du Thau off the coast of the Gulf of Lion (S. France).

DESCRIPTION OF SPECIMENS FROM ETANG DU THAU (FIG. 1.)

The shell colour ranges from almost white to dark brown (more often). The shell is thin, fragile, its length ranges from 4 to 12mm. It is anteriorly rounded, posteriorly elongated, obliquely shaped. The number of radial ribs is between 23 and 25. They are of the same width as the intercalating furrows. The rib system is reflected in the internal side of the shell. The anterior and posterior ribs have a few knobs. The shell pointed umbo is hooked in the direction of ligament. The ligament is narrow, flat, long and extending halfway to the posterior margin of the shell. The hinge consists of two cardinal and two lateral teeth in each valve.

BIOLOGY AND ECOLOGY OF SPECIES

The habitat where *P. hauniense* was found is a shallow water, non tidal lagoon (étang). Only after a strong, north wind (tramontagne) is water mass pushed out from étang to sea and the

¹ Institute of Oceanography, Gdańsk University, Al. J. Pitsudskiego 46, 81–378 Gdynia, Poland.



Fig. 1. Shell of *Parvicardium hauniense* from the étang du Thau. Drawings by S. Szymański.

water level decreases up to several centimetres. All cockles were collected in the near shore zone with a water depth ranging from 0.3 to 0.8 m. They were attached by byssus threads to chlorophyte and phaeophyte vegetation. Specimens living in the bottom were not detected. The ecological conditions known from the Baltic Sea differ considerably from those in the environment occupied by *P. hauniense* in the étang du Thau.

The range of temperatures observed in the étang were from 3 to 35°C which is higher than in the Baltic Sea where they range from 0 to 25°C (Russell & Petersen 1973).

Salinity ranged from 18 to 42‰, and was subject to abrupt changes depending upon the direction of the wind. *P. hauniense* was not found to avoid fresh water, which can be noted by its presence in the region of the estuary of the River Vene. The river is highly polluted with municipal sewage. In the Baltic Sea *P. hauniense* occurs in waters with a salinity from 8 to 12‰ (Ls50 from 9 to 13‰) (Russell & Petersen 1973) and 6–7.5‰ in Gdansk Bay (Wołowicz 1987b). *P. hauniense* was never found exposed to air and it occurs in areas where tidal amplitudes did not exceed 0.1 m. The dissolved oxygen in étang du Thau amounted to 3.30–11.84 mgO₂ l⁻¹ and may fall to zero in summer with short term occurrences of H₂S on the bottom in the same area where the cockles are found. In the étang du Thau *Parvicardium hauniense* occurs together with *Cerastoderma glaucum*.

A wide tolerance range to salinity, temperature and other environmental factors indicates high plasticity and adaptability of the species. However, further ecological and ecophysiological research is required. Because of its occurrence in the Mediterranean basin, its occurrence in other brackish water areas of the European coast, as in the case of *Cerastoderma glaucum*, cannot be excluded.

The specimens sampled in the étang du Thau are housed in the Institute of Oceanography at Gdansk University.

ACKNOWLEDGEMENTS

I am grateful to Dr. J. M. Deslous-Paoli for his kind help and the hospitality offered me during my stay at the IFREMER laboratory at Sete, France.

REFERENCES

- JELNES, J. E., PETERSEN, G. HØPNER & RUSSELL, P. J. C., 1971. Isoenzyme taxonomy applied on four species of *Cardium* from Danish and British waters with a short description of the distribution of the species (Bivalvia). *Ophelia*, **9**: 15–20.
- PETERSEN, G. HØPNER & RUSSELL P. J. C., 1971a. *Cardium hauniense* nov.sp. a brackish water bivalve from the Baltic. *Ophelia*, **9**: 11–13.
- , 1971b. *Cardium hauniense* compared with *C. exiguum* and *C. glaucum*. *Proc. malac. Soc. Lond.*, **39**: 409–420.
- , 1973. The nomenclature and classification of some European shallow water *Cardium* species *Malacologia*, **14**: 233–234.
- RUSSELL, P. J. C. & PETERSEN, G. HØPNER, 1973. The use of ecological data in the elucidation of some shallow water European *Cardium* species. *Malacologia*, **14**: 223–232.
- WOŁOWICZ, M., 1977. Rozmieszczenie oraz biomasa *Cardium glaucum* (Poiret 1789) i *C. hauniense* (Petersen, Russell 1971) w wodach Zatoki Puckiej wewnętrznej. *Oceanografia*, **5**: 103–115.
- , 1987a. A comparative study of the reproductive cycle of cockles *Cardium glaucum* (Poiret 1789) and *C. glaucum* (Petersen, Russell 1971) (Bivalvia) from the Gdansk Bay. *Pol. Arch. Hydrobiol.*, **34**: 91–105.
- , 1987b. Larval development of *Cardium glaucum* and *C. hauniense* (Bivalvia) from the Gdansk Bay. *Pol. Arch. Hydrobiol.*, **34**: 107–117.

THE RADULA OF *ACTEON TORNATILIS* (L.) (OPISTHOBRANCHIA: ACTEONIDAE)

N. YONOW¹

(Accepted for publication, 14th December, 1991)

Abstract: Light microscope and SEM preparations have been made of the radula of *Acteon tornatilis* (Linnaeus) (Opisthobranchia: Cephalaspidea). The minute teeth are illustrated with SEM photographs, the first time they have been accurately depicted. Comparisons with other acteonid radulae are given, as well as possible function now that diet is known.

INTRODUCTION

The shelled cephalaspid *Acteon tornatilis* (Linnaeus) occurs on moderately sheltered intertidal and shallow subtidal sands on the south-west and west coasts of Britain. It was thought to feed on tubicolous polychaete worms (Hurst 1965, Rudman 1972), and under experimental conditions has been shown to display a preference for *Owenia fusiformis* Delle Chiaje over the Sand Mason *Lanice conchilega* (Pallas), which nevertheless provides a proportion of the prey of the study population (Yonow 1989). At Rhossili, Gower Peninsula, South Wales, where a population of the opisthobranch has long been known to occur, *Acteon* may be found at low tide attached to and actively feeding on both species of worm.

The radular teeth of *Acteon tornatilis* have never been adequately illustrated, and published descriptions are somewhat vague, describing infinite rows of numerous tiny teeth. This study illustrates and describes the radula of *A. tornatilis* in detail for the first time, using scanning electron micrographs.

METHODS

Radula preparations were made by dissolving the whole head region of individual *Acteon*, with the shell removed, in 5–10% aqueous NaOH, warmed on a hot plate. The radulae were then washed in several changes of water and mounted in polyvinyl lactophenol stained with lignin pink. The radula used for SEM was washed and placed in 100% acetone, ready for coating.

RESULTS AND DISCUSSION

The *Acteon tornatilis* radula is very tiny indeed. In three specimens of shell lengths 13 mm, 14 mm, and 18 mm, the radulae measured 0.8 mm, 1.6 mm, and 1.5 mm in length respectively. The teeth are of a similar shape and size along both the width and the length of the radula (Fig. 1A), with the usual wearing of teeth occurring anteriorly. The teeth measure 6–9 μm in

¹ Marine Research Group, School of Biological Sciences, University College of Swansea, Swansea SA2 8PP, Wales, U.K.

height, and are abruptly hooked in shape (Fig. 1B), with a large solid root and a cusp divided into 13–17 very fine denticles $1.5\text{--}2.5\ \mu\text{m}$ long (Fig. 1C).

Gabe & Prenant (1952) described, for two Roscoff specimens of *A. tornatilis*, “a large radula” (the length was not stated) with numerous equal-sized teeth. They estimated 170 teeth per half row but gave no indication of the number of rows. The radula and radular teeth of *A. tornatilis* are so small that it is extremely difficult to count either the number of tooth rows, or the number of teeth per row. Unfortunately, preparation of the radula for both light microscopy and scanning electron microscopy results in distortion of the organic radular ribbon, which increases the difficulty of making accurate counts. However, it is possible to derive estimates of tooth and row numbers from counts of measured areas made from SEM micrographs of undistorted portions of the radula, the length and width of which were recorded prior to preparation. Minimum and maximum estimates (allowing for overlap of teeth and rows) for the radula of a 14 mm *Acteon tornatilis* with a radular length of 1.6 mm (1.37 mm after SEM coating) and width of 0.47 mm (after SEM coating) are as follows:

$$161\text{--}235 \times 45\text{--}72.0.72\text{--}45$$

A second estimate could be arrived at using only tooth size measured from the SEM micrographs. Given a maximum tooth length of $9\ \mu\text{m}$ and a radular length of $1370\ \mu\text{m}$, there would be 152 rows of teeth; allowing a basal width of $5\ \mu\text{m}$ (Fig. 1) and a radular width of $470\ \mu\text{m}$ gives an estimate of 94 teeth per full row. The estimated radular formula would thus be:

$$152 \times 47.0.47$$

This latter must be regarded as the minimum estimate, given that, despite micromanipulation, it is impossible to obtain a perfectly flat preparation of the radula for SEM.

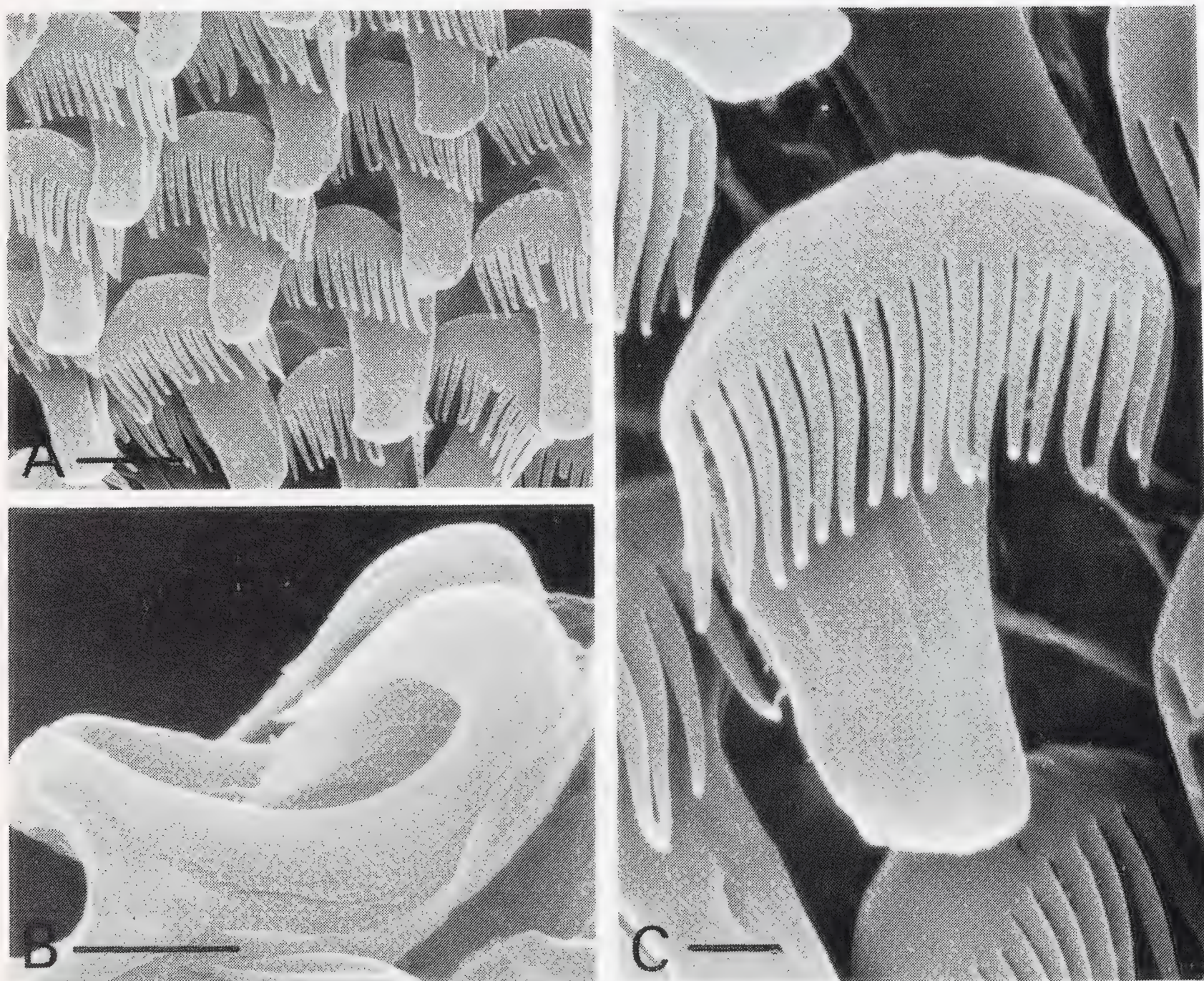


Fig. 1. Scanning electron micrographs of the radula of *Acteon tornatilis*.

A. Frontal view of a few rows of teeth from the growing edge (scale = $3\ \mu\text{m}$).

B. Lateral view of two teeth from the central edge of the radula (scale = $2\ \mu\text{m}$).

C. One tooth from the central edge (scale = $1\ \mu\text{m}$).

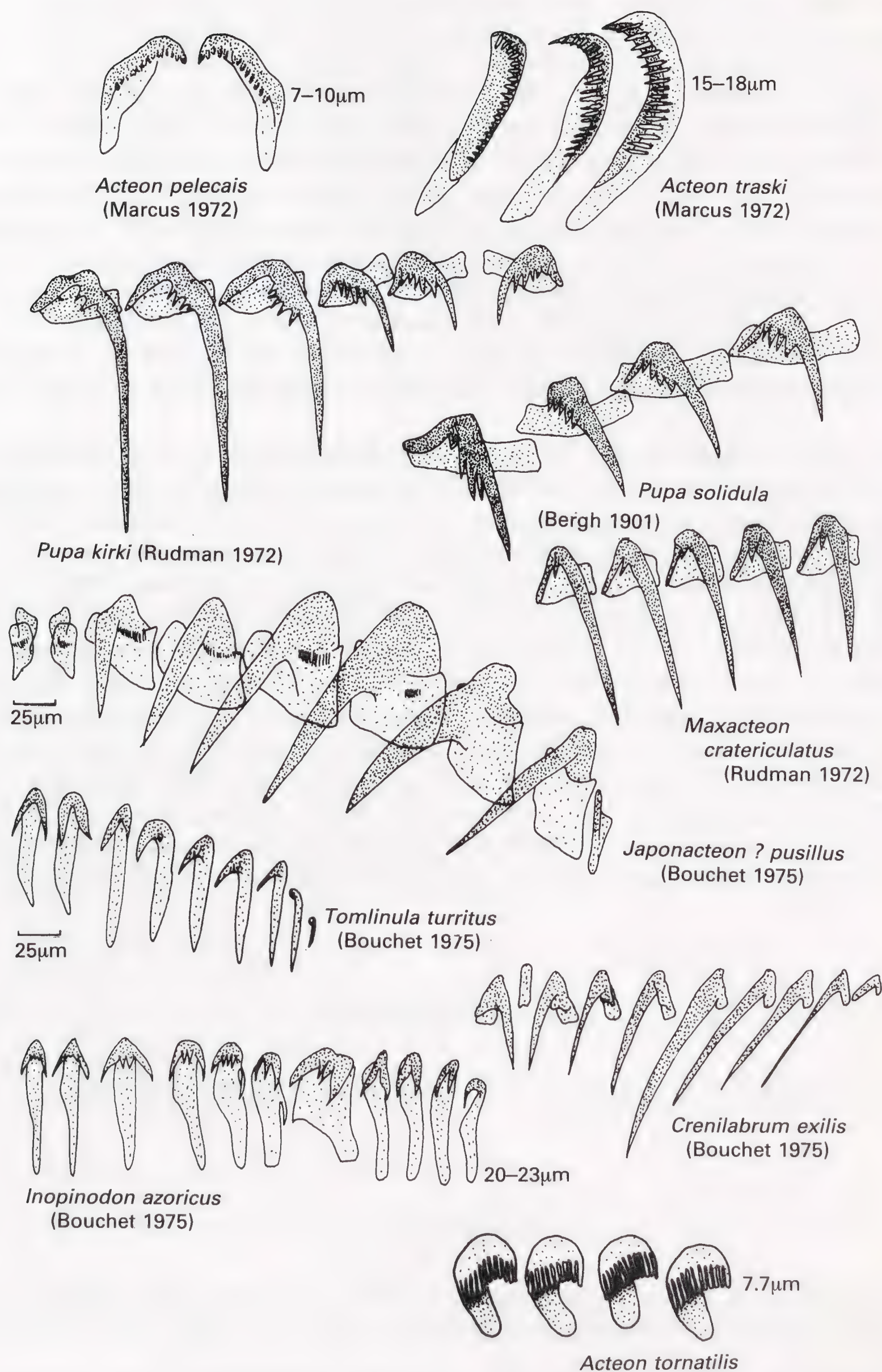


Fig. 2. Selected teeth of various species of Acteonidae, drawn from stated sources. NB: scales are given where available, and differ between figures.

The radula of *A. tornatilis* is rather unusual for the family, but seems to be typical of the genus (Fig. 2): Marcus (1958 as *A. punctostriatus* (C. B. Adams), 1972) described the teeth of *Acteon pelecais* Marcus (1971) as innumerable, small, and hook-shaped. The radular teeth of *A. traski* Stearns are similar, estimated at 200 teeth per half row with more than 200 rows (Marcus 1972). The small size of the radula and the identical minute teeth serve to distinguish *Acteon* from other genera in the family. The teeth of *Maxacteon cratericulatus* (Hedley) and *Pupa kirki* (Hutton), both inhabitants of muddy sands feeding on polychaetes, have one long denticle on each tooth, in addition to one or more small ones (Rudman 1972). Bergh (1901) illustrated the radular teeth of *Pupa solidula* (Linnaeus), and they are most similar to those of *P. kirki* in having a flattened root, or basal plate, and one long spine on each cusp. Bouchet (1975) illustrated teeth for four species of deep sea Atlantic acteonids, and gives sizes for three. The genus which most resembles *Acteon* in the size and quantity of teeth is *Inopinodon*: *I. azoricus* Locard has tiny teeth, 23 μm long, which vary in shape along the width of the radula. They are similar in shape to *Acteon* teeth except in having a large sharp denticle on each side of the cusp, with a few smaller ones in between. *Crenilabrum exilis* (Jeffreys) and *Japonacteon ?pusillus* (Forbes) have teeth similar to *Pupa*, with a large oblong root and one long denticle. The teeth of *J. ?pusillus* are 250 μm in length. The teeth of *Tomlinula turritus* (Watson) are 50 μm in their largest dimension and have a stem-like root with two sharp denticles forming the cusp. The various teeth described above are illustrated in Fig. 2.

Rudman (1972) suggested that the acteonid radula is adapted to a specialized diet of polychaetes, which seems probable. In *Pupa* and *Maxacteon*, it may be used to hold the worm while the buccal bulb acts as a suction pump: one must infer from Rudman (1972) that the size of the teeth is larger than that of the species belonging to the genus *Acteon*.

A. tornatilis has been shown to feed on tubicolous polychaetes (Yonow 1989). Two species are common in the natural habitat of this opisthobranch, *Owenia fusiformis* and *Lanice conchilega*. The results of a series of choice experiments suggest that *Acteon* actually prefers *Owenia*, possibly because this species lives in short tubes which are pointed at both ends, preventing rapid movement and escape of the worm. The teeth of *A. tornatilis* seem too small to hold the prey polychaete, as in *Pupa* and *Maxacteon*, especially as they lack the large denticles characteristic of the other genera. Instead, it seems possible that in *Acteon* the teeth may be used for rasping away at the membrane secreted by the worms onto which the sand grains are attached, the teeth passing easily between the grains. The finely denticulate cusps provide an abrasive surface to the radula, analogous to that of a fine sand paper.

ACKNOWLEDGEMENTS

I would like to thank Dr. P. J. Hayward for his comments on the manuscript.

REFERENCES

- BERGH, R., 1901. Bullacea. In Semper, Reisen im Archipel der Philippinen. *Wissenschaftliche Resultate*, **7**: 209–338.
BOUCHET, P., 1975. Opisthobranches de profondeur de l'océan atlantique. L. Cephalaspidea. *Cah. Biol. Mar.*, **16**: 317–365.
GABE, M. & PRENANT, M., 1952. II. Recherches sur la gaine radulaire des mollusques. L'appareil radulaire d'*Acteon tornatilis* Linné. *Arch. Zool. exp. et gen.* **89**: 15–25.
MARCUS, E., 1958. Notes on Opisthobranchia. *Bolm. Inst. Oceanogr. S. Paolo*, **7**, 31–78.

YONOW: THE RADULA OF *ACTEON TORNATILIS* (L.)

——, 1972. On some Acteonidae (Gastropoda, Opisthobranchia). *Pap. Av. Zool., S. Paolo*, **25**: 167–188.

RUDMAN, W. B., 1972. Structure and functioning of the gut in the Bullomorpha (Opisthobranchia). II. Acteonidae. *J. nat. Hist.*, **6**: 311–324.

YONOW, N., 1989. Feeding observations on *Acteon tornatilis* (Linnaeus) (Opisthobranchia: Acteonidae). *J. Moll. Stud.*, **55**: 97–102.

REVIEW

Compendium of Seashells – A Full-Color Guide to More than 4200 of the World's Marine Shells. By R. Tucker Abbott & S. Peter Dance. Charles Letts & Co., London. ix + 411 pp, 3 black-and-white text figures, numerous colour plates. 1991. ISBN 1852381345. £40.

This is a reprint of the 3rd edition of the *Compendium* published in 1986. It differs from the 1st edition (published in 1981) only in the correction of several figure captions (marked by an asterisk) and in the addition of an extra page (p. 411) listing further corrections which are left to the reader to carry out. It starts with a 17-page introduction on the classification, taxonomy, morphology, identification and habitat of marine molluscs, together with useful hints on the care and conservation of shells in collections. The main part of the book is an iconography of over 4200 marine shells, including nearly 1000 bivalves. The species are arranged in family groups whose sequence follows the usual systematic order from the more primitive Pleurotomariidae to the highly developed Nautilidae. All shells are illustrated by colour photographs of approximately the same size (from 3.5×5 to 4×6 cm). There are up to 12 such photographs on a page, interspersed with short descriptions of family characteristics at the beginning of each new family. The photographs are accompanied by brief captions giving the popular name and the average size of the shell, its scientific name, author, date, habitat, rarity and basic synonymy in a standardized form. There are no morphological descriptions. The iconography is followed by a 12-page taxonomic classification down to family level, combined with a bibliography of the major sources for each family up to 1981. The book ends with a short 2-page index of popular names and a detailed 18-page index of scientific names.

The *Compendium* is aimed primarily at the amateur conchologist, particularly the general collector of worldwide seashells, looking for a single reference book to aid identification. It covers all the major families whose shells are of 'collectable' size (say not less than 1 cm across), including bivalves which get a short shrift in many shell books. Families of particular interest to collectors (cowries, cones, volutes, scallops etc) are given preferential treatment, reflected in the large number of their species included. The quality of the colour photographs is mostly good, sometimes excellent and only a minority is so indistinct that the shells are hardly recognizable. Two features of the book rather exceed the requirements of its primary target, but they are both welcome by the more serious students of molluscs. One is the inclusion of several hundred shell photographs taken from type specimens, the other is the detailed bibliography of major sources in the classification section.

Besides its many virtues, the *Compendium* also has some shortcomings. The publisher's claim that it makes shell identification 'quick and certain' is open to question. Since the figure captions don't give morphological description, the identification hinges entirely on the photographs, some of which don't show enough detail to allow an unambiguous conclusion. Others illustrate only a single form of a very variable species, which may be different from the one to be identified. In addition, there are still a number of errors left in the captions which can lead to misidentification. One example is the caption of the first figure on p. 196 which reads: '**Chinese Ancilla.** *Ancilla rubiginosa* Swainson, 1823. China Sea'. It should read: '**Similar Ancilla.** *Amalda similis* (Sowerby, 1829). Mozambique'. Here not only the taxonomy is incorrect but the habitat as well.

Another shortcoming, which specifically applies to the third edition, arises from the lack of updating in the bibliography and the index. When the *Compendium* was first published in 1981, the bibliography was up to date, and the species names in the captions were in harmony with the index. Neither of these is true in the 3rd edition. The bibliography of the 3rd edition ignores all the molluscan literature published since 1981 and so it is out of date. Furthermore, the name-changes in the corrected captions of the 3rd edition have not been transferred to the index, so that there is now a discrepancy between the captions and the index. Finally, it is rather strange to see a book published in London using American spelling (color, catalog etc.) – a small point, but an irritation.

To sum up: the 1st edition of the *Compendium* was probably the best book available at that time for its intended readership. Its popular appeal is well reflected in the number of editions and reprints it has reached. Had the 3rd edition been thoroughly revised and its bibliography and index updated, one could have said much the same about this as well. But it is hard to see, how a partially corrected reprint of a ten year old popular book with an out-of-date bibliography and index can justify its current retail price.

ENDRE SÁNDOR

THE DISTRIBUTION OF *PUPOIDES* *COENOPICTUS* (HUTTON, 1834) IN NW. AFRICA (GASTROPODA: PUPILLIDAE)¹

M. B. SEDDON²

(Accepted for publication, 15th February, 1992)

Abstract: The northern limit of the range of *Pupoides coenopictus* in NW. Africa has been extended to include the northern edge of the Sahara. A distributional survey of the Magreb region showed that this species formerly occurred in regions of S. Morocco and N. Algeria. This paper describes the range of *Pupoides coenopictus* in NW. Africa, discusses systematic status and taxonomic problems and comments on possible factors limiting the range.

INTRODUCTION

During the period 1984–1988 a distributional survey of the land Mollusca of NW. Africa was carried out. The sites examined covered a range of habitat types and included material of Quaternary age. Data was collected from over 700 sites in the region; site records include details of slope angle, geology, vegetation, elevation and accurate latitude and longitude co-ordinates. This paper summarises the data relating to the range of *Pupoides coenopictus* in Morocco and Algeria.

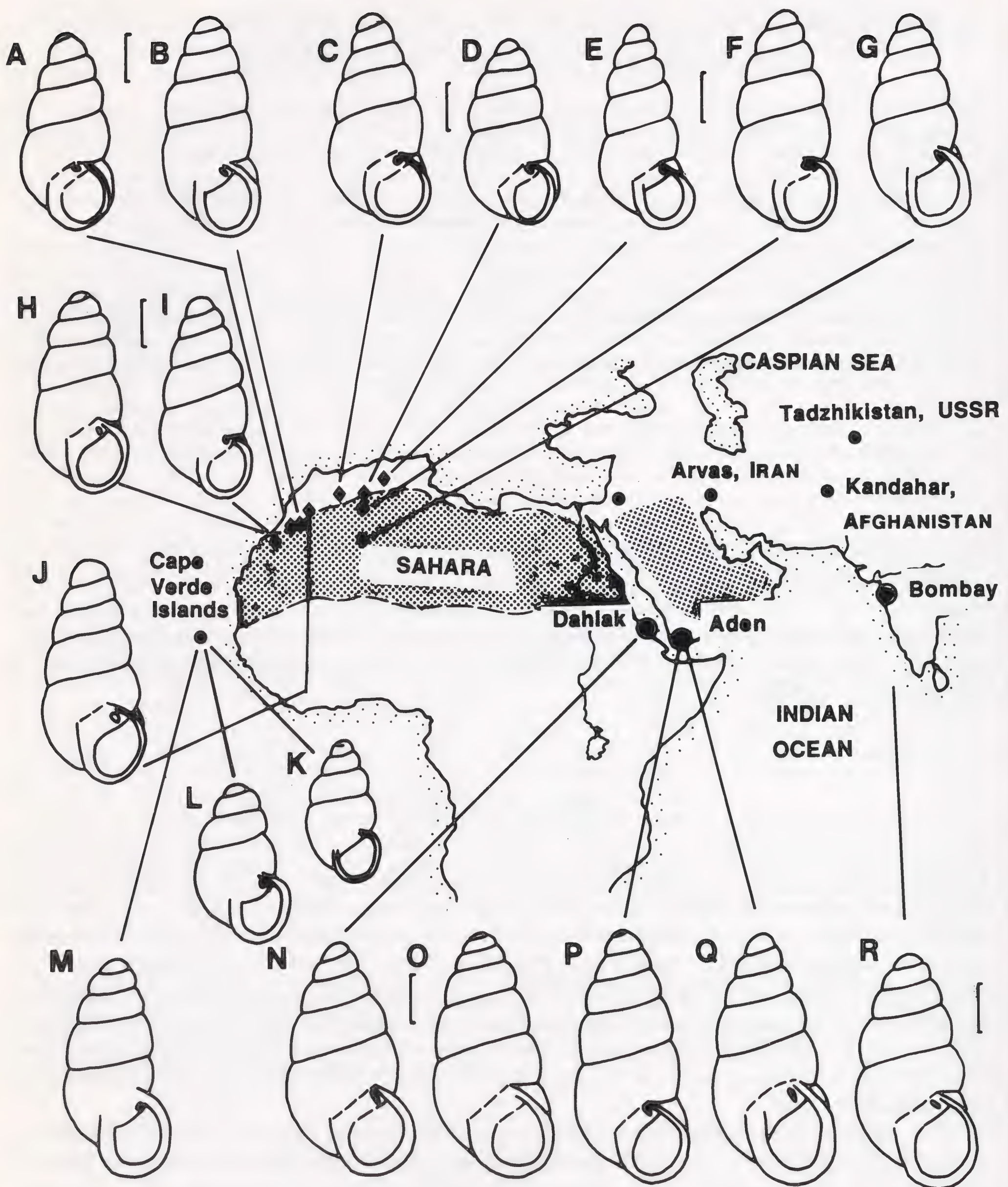
PREVIOUS WORK

The distribution of species presently placed in the genus *Pupoides* covers the drier parts of tropical and subtropical regions in America, Asia and Africa. Pilsbry (1920–1) provided the most extensive survey of the genus. The shell form of species placed in the genus *Pupoides* is similar to those in families Enidae and Pupillidae. This has led to the genus *Pupoides* L. Pfeiffer, 1854 being placed in either the family Enidae or Pupillidae by different authors; it has also led to the argument that the families Enidae and Pupillidae have close affinities (Pilsbry 1921: 108–109). Recently Shileyko (1984) obtained spirit material of specimens from the Red Sea region; based on the genital anatomy he placed this genus in the Pupillidae subfamily Pupillinae.

This paper only considers species which may be forms or synonyms of *Pupoides coenopictus* within N. Africa. Pilsbry (1921: 121) pointed out that, within the region of Africa, the Middle East and SW. Asia, numerous nominal species may be forms or synonyms of *P. coenopictus*. Pilsbry did not agree with those who argued that all the American species should also be included in this single species. Morelet (1872) certainly regarded *P. senegalensis*, *P. putilla*, *P. senaariensis*, *P. cerealis* and *P. vermiformis* as synonyms of *P. coenopictus*. Morelet also suggested

¹ Systematics and Biogeography of the Land Mollusca of NW. Africa. Contribution no 5.

² Dept of Zoology, National Museum of Wales, Cathays Park, Cardiff, CF1 3NP, UK.



that *P. gemmula* from the Cape Verde islands may be a dwarf form of *Pupoides coenopictus*. Pilsbry (1920–21) commented on the variability of shell forms in Asia and Africa and the lack of comparative data in the original species descriptions. As the shells in the National Museum of Wales collections are very variable it seems best to take a broad view of the species *Pupoides coenopictus* pending a wide-ranging revision using data from different geographical regions.

PUPOIDES L. Pfeiffer, 1854

PUPOIDES L. Pfeiffer, 1854 *Malak. Bl.*, 1: 192

***P. coenopictus* (Hutton, 1834)**

Pupa coenopicta Hutton, 1834, *J. asiat. Soc. Beng.*, 3: 85, 93.

Material examined: Melvill-Tomlin Collections, National Museum of Wales has specimens with the following names, some of these specimens are illustrated in Fig. 1. *P. coenopictus* Hutton, 1834 [3 lots including 1 lot from the type locality Bombay, India; 14 shells]; *P. tutulus* [Benson ms.] Reeve, 1849 [2 shells, Bombay, India]; *P. lardeus* L. Pfeiffer, 1852 [6 shells; 'Old Indien']; *P. senaariensis* L. Pfeiffer, 1855 [2 shells (Coll. Pallary); Cairo, Egypt]; *P. cerealis* Paladilhe, 1872 [2 lots; Jebel Gaad (Coll. Pallary), 8 shells; Aden, 2 shells]; *P. samavaensis* (Paladilhe, 1872) [Aden]; *P. fabianus* Gredler, 1875 [3 shells, Dahlak, Red Sea]; *P. Soror* Preston, 1912 [ex Auct., syntypes, 17 shells, Chanler Falls, Eusso Nyiro, Kenya], *P. senegalensis* Morelet, 1848 [4 shells, Senegal]. Material in the Holyoak & Seddon Collection from 37 sites in Morocco and Algeria; these records are shown in Fig. 2.

On the basis of shell morphology the names given above appear to be synonyms of *Pupoides coenopictus*. In the literature the following names have also been given as synonyms of *Pupoides coenopictus*: *astieranis* Dupuy, 1849; *putillus* Shuttleworth, 1852; *?doriae* Issel, 1865; *fallax* Jickeli, 1874 (non Say); *euphraticus*, *kursiensis*, *maharasicus*, *marebiensis*, *reboudi* Bourguignat, 1876; *aethiopicus* Bourguignat, 1883; *sennaaricus* [sic] Bourguignat, 1883; *ragius* Jousseaume, 1889; *harti*, Tristram in Hart, 1891; *hoggarensis* Pallary, 1929. Illustrations of *euphraticus*, *kursiensis*, *maharasicus*, *marebiensis*, *reboudi*, *aethiopicus*, and *hoggarensis* show that these are also probably synonyms of *Pupoides coenopictus*.

Shell: The broad view of the species taken here includes a wide variation in shell form and size. Illustrations of these 'forms' can be found in Pilsbry (1921, Pls. 13, 14); one other species

Fig. 1. (opposite) Shell morphology of *Pupoides coenopictus*. Scale bar represents 1mm. The map shows locations of the material illustrated. The shaded areas represent the approximate extent of desert regions.

A,B. *Pupoides coenopictus* by road 7084 on E. side of Oua-Belli, Morocco 29°13'N, 8°32'W [HS#1986.384.02] NMWZ. 1987.001.009.

C. *Pupoides coenopictus* by P 19 1.5 km NW. of Figuig, Morocco 32°08'N, 1°14'W, [HS#1986.119.02] NMWZ. 1987.001.010;

D. *Pupoides coenopictus* 1 km SE. of N46 at 4 km SW. of Bou-Saada, Algeria, [HS#1984.306.3] NMWZ. 1986.117.001;

E. *Pupoides coenopictus* by N46 14 km of Foughala (WSW of Biskra) [HS#1984.302.1] NMWZ. 1986.117.002;

F. *Pupoides coenopictus* by N1 © 11 km. NW. along road from Berriane, (N. of Ghardaia), Algeria [HS#1984.222.2] NMWZ. 1986.117.003;

G. *Pupoides coenopictus* by N1 © 95 km N. of In Salah, Algeria. 28°00'N, 2°40'E [HS#1989.6.1] NMWZ. 1989.098.029

H,I. *Pupoides coenopictus* by P 44 © 43 km SW. along road from Smara, Morocco 26°37'N, 12°05'W [HS#1986.245.1] NMWZ. 1987.001.011;

J. *Pupoides coenopictus* by P32 © 22 km ENE along road from Ouarazazate, Morocco, 30°58'N, 6°41'W [HS#1986.355.02] NMWZ. 1987.001.012

K. *Pupoides gemmula* (Benson, 1856) Sao Vincente, Cape Verde Islands, shell outline drawn from material figured by Groh (1983) SMF 255904;

L. *Pupoides gemmula* (Benson, 1856) Sal, Cape Verde Islands, shell outline drawn from material figured by Groh (1983) SMF 255902;

M. *Pupoides coenopictus senegalensis* (Morelet, 1848) Brava, Cape Verde Islands, shell outline drawn from material figured by Groh (1983) SMF 255900.

N. *Pupoides coenopictus fabianus* Gredler, 1875 'Daklak' (=Dahlak) Melvill-Tomlin Colln. NMWZ 1955.158.1478; (island where Shileyko obtained material for anatomy);

O. *Pupoides coenopictus sennaaricus* Pfeiffer 1855 'Le Caire' (= Cairo) noted [Pallary] Melvill-Tomlin Collection NMWZ 1955.158.1479;

P. *Pupoides coenopictus crealis* Paladilhe 'Jebel Gard' (Aden?) Melvill-Tomlin Collection NMWZ 1955.158.1480;

Q. *Pupoides coenopictus samavaensis* (Paladilhe, 1872) Aden, Melville-Tomlin Collection, NMWZ 1955.158.1481;

R. *Pupoides coenopictus coenopictus* (Hutton, 1834) Bombay, India, Melvill-Tomlin Collection NMWZ 1955.158.1482.

HS = Holyoak and Seddon collection; NMWZ = National Museum of Wales.

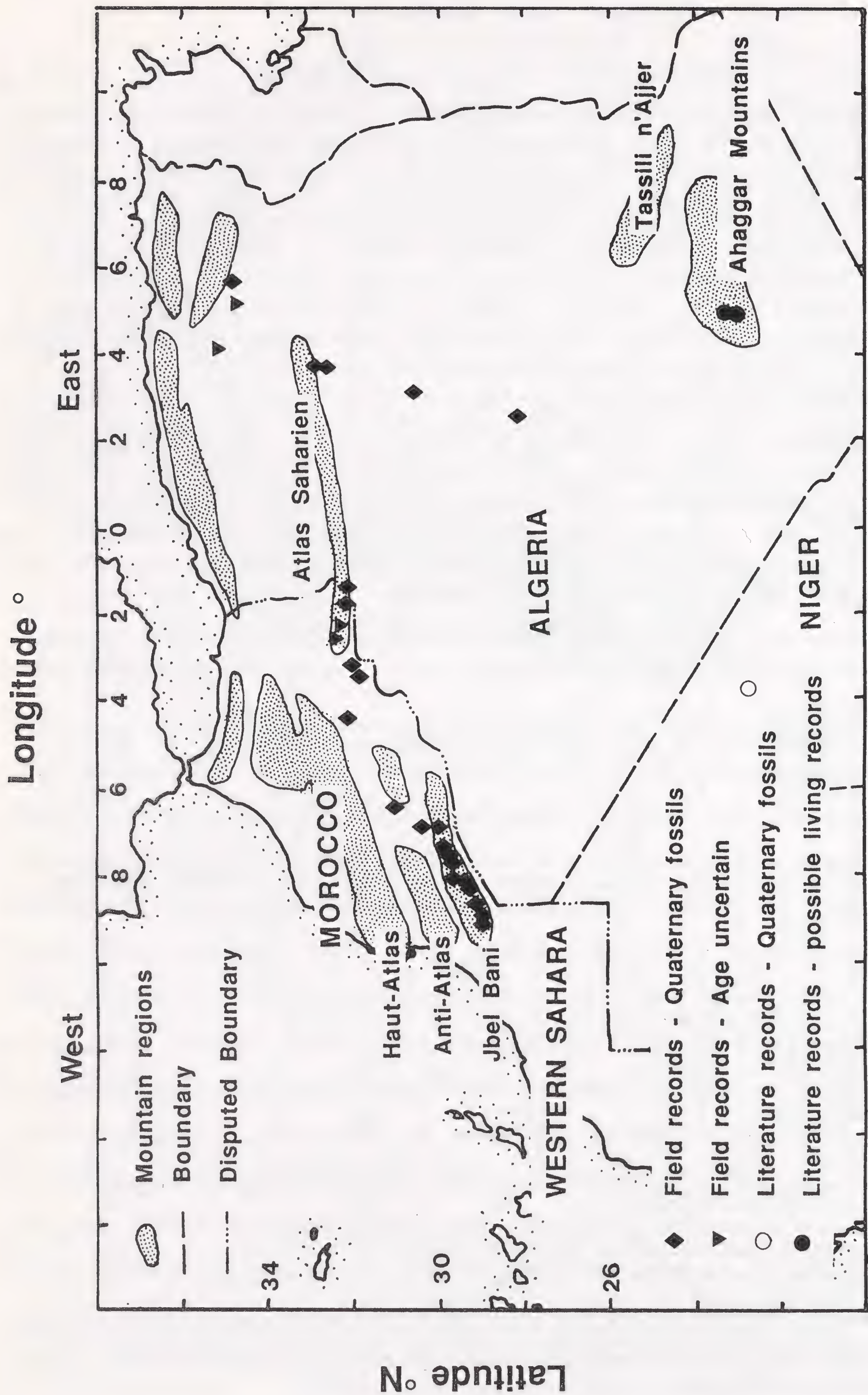


Fig. 2. The distribution of *Pupoides coenopictus* in NW. Africa.

from NW. Africa was illustrated by Pallary (1934) in his paper on the Mollusca of the central Sahara. The other species described from NW. Africa '*Bulimus reboudi*' Bourguignat (1876) has apparently not been illustrated; the shell description coupled with material from the region (Holyoak & Seddon Collection, NMWZ) suggests that this is a synonym of *Pupoides coenopictus*. Shileyko (1984), in his brief study of the status of the genus *Pupoides*, examined shells from a range of localities in SW. Asia:— 4 specimens from the sediment of the River Vaksh near the nature reserve at Tigro-vaya Balka (Tadzhikistan, USSR); 1 specimen from Kandahar, Afghanistan; 5 specimens from Arvas, Iran; and 12 specimens from the island of Harat, Dahlak archipelago in the Red Sea. Other more recent illustrations of specimens from the Cape Verde Islands can be found in Groh (1983). The suggestion that *P. gemmula* is a dwarf form seems possible as the principal differences are size of the shell and compression of the whorls. Morelet (1872) and Wollaston (1878) recorded only *P. gemmula* on the Cape Verde Islands in the size range 3–4 mm. However, Groh (1983) recorded both *Pupoides coenopictus senegalensis* (4.6 mm; 7 specimens) and *P. gemmula* (3.74 mm; 16 specimens from 3 sites) from the same locality on the island Bravo in the Cape Verde Islands. There are at least two explanations for these differing records; (a) *Pupoides coenopictus senegalensis* may be a recent introduction to Bravo; (b) *Pupoides coenopictus senegalensis* varies in size from the coast of Senegal to Cape Verde Islands and those specimens on Bravo are intermediate in size.

Outline drawings of shells from the sites in NW. Africa are shown in Fig. 1. This shows a range in size, shape and proportion of the mouth and depth of suture. Immature shells from a few sites in Morocco show similar characters to those of Fig. 1 K. To illustrate the variation in shell size and shape specimens from the Arabian Peninsula and India are also shown. Material is from either the Holyoak & Seddon Collections or the Melvill-Tomlin Collections at the National Museum of Wales. Drawings of specimens from the Cape Verde Islands are shown; the originals were figured by Groh (1983, Pl. 16).

Genital Anatomy: Shileyko (1984) was the first to look at the genital anatomy of this species. The material dissected and figured (Shileyko 1984: 195, Fig. 113B) came from the island of Harat, Dahlak archipelago in the Red Sea. These specimens were collected in February 1980. The type locality of the species described by Hutton was in the region of Bombay, India. Hence the material dissected is not topotypical. The shell form of the material dissected was not illustrated by Shileyko (*op. cit.*). The literature on the area suggests that the name *Pupoides fabianus* applies to specimens from this area. Material in the Melvill-Tomlin collections (NMWZ) from these regions (including *Pupoides fabianus*) is also shown in Fig. 1 to show the variability in shell shape, especially the shape of the mouth, the extent to which the lip is reflected and the development of the angular tooth. The specimens in the NMWZ collections show that *Pupoides fabianus* has a paler shell with a slightly smaller aperture than typical *Pupoides coenopictus* and the lip is more strongly reflected with a bigger angular tooth. However, given the variation through the region these differences may not be significant. The genital anatomy figured by Shileyko shows similarities to Caribbean material of *Pupoides marginatus nitidulus* (Pfeiffer, 1839) (Baker 1935). Baker suggested that the genus *Pupoides* has the simplest genitalia in the Pupillinae.

Therefore, in the absence of other data from other regions on genital anatomy it seems best to regard *Pupoides coenopictus* as a single, rather variable species with a broad geographical range. It is possible that detailed examination of the anatomy of material from different regions, especially from the type locality, will change the current view of the broad species limits described above.

Range: The range of *Pupoides coenopictus* in NW. Africa was known to include desert and desert edge regions in SW. Sahara (Fischer-Piette 1950), N. Mauritania and N. Mali (Fischer-Piette 1949) and S. Algeria (Pallary 1934); Quaternary fossils were also reported further

north in SE. and C. Algeria (e.g. Ahaggar, Pallary 1929, 1934); [an erroneous report from the Rif, N. Morocco given by Fischer-Piette (1949) was corrected by Fischer-Piette (1950)]. There is one record of unknown age from floodline debris or wadi deposits of the Oued Roumana in north central Sahara close to Bou Saada (Bourguignat 1876: 24). In the Holyoak & Seddon Collection there are Quaternary specimens from a site close by.

Elsewhere, the species has been recorded from Cape Verde Islands (Groh 1983), tropical Africa from Senegal (Morelet 1848) and N. Niger (Air Mts, Verhaeghe 1983) to Somalia (Pilsbry 1921–2) and Egypt (Pallary 1909); to SW. Asia including Israel (Mienis 1974, 1979), S. Arabia, Iraq, Iran (Starmühler & Edlauer 1957), Afghanistan, (Shileyko 1984); India (Hutton 1834), Ceylon (Pilsbry 1921–2); there are also records from S. France (Germain 1931–2), West Indies and S. Africa where it was thought to have been introduced last century (Pilsbry 1921–2: 124–125). Quaternary fossils of *Pupoides coenopictus* have also been recorded from archaeological sites in Israel and Sinai (Bar-Yosef *et al.* 1986, Mienis 1990). These provide evidence that *Pupoides coenopictus* is not a recent introduction to Israel and Sinai, but has been present for at least 5000 years.

Ecology: Published records from NW. Africa give little ecological data. Pallary (1929) reported '*hoggarensis*' from 2150 m elevation in the Ahaggar. Pallary (1934) using material collected by Capt. Morrel gives records of *Pupoides coenopictus* living at Akator in the Ahaggar Mountains to the north of Tamanrasset. In this region one specimen was found at the base of an *Olea* and another came from the leaf litter at the foot of 'Balottes' near an intermittent waterfall at 1650 m A.S.L. Further south in the Air Mts. of Niger Verhaeghe (1983) found this species living abundantly in sandy alluvial gravels at a depth of 10–30 cm beneath the surface. Thus the sites in the Sahara where the species was presently found living were all in mountain regions with habitats which had more humid microclimates.

In NE. Africa Bourguignat (1883: 114) reported this species from around 4000 m elevation on the high plateaux of Ethiopia, whereas Pallary (1909: 41) reported it from low elevations near Cairo. No data were given for the habitats.

Hutton (in Pilsbry 1921: 124) noted that in India he found it "adhering to the face of a bare and very steep rock [facing east]", that "they were scattered over the bleak face of the rock in great numbers" and that the shell is covered with a coating of mud. Also in India, Benson (in Pilsbry, 1921) found it "abundant under stones and rocks" and "on mud walls and under tiles".

DISTRIBUTION AND HABITATS IN NW. AFRICA

This survey shows that the former limit of the range of *Pupoides coenopictus* extended to the mountains on the north edge of the Sahara (Fig. 2). In Morocco the species was found at many localities in the Jbel Bani and even into the southern part of the Haut-Atlas. The most western record was in the low areas around Smara in Western Sahara. These records were all from sites of either Quaternary fossils (33) or of uncertain age (4) (probably Quaternary, but from the context difficult to assign this status with full confidence). Records were also found in the regions between this northern limit and those previously known. The material from sites shown in Fig. 2 are from the Holyoak & Seddon Collections (National Museum of Wales 1986. 117, 1987.001 and 1989.098). The literature records for this region are also shown. The nearest presumed living records were from the Ahaggar Mountains in Southern Algeria (Pallary 1934).

The records from Algeria are from elevations of 240–750 m A.S.L. in regions which are very dry at present, with little or no vegetation; most are from rocky crags (limestone: 5,

calcareous sandstone: 2), with one record from sand deposits beside a dry wadi bed. The associated faunas included *Granopupa granum* (Draparnaud) (5 sites), *Zootechus insularis* (1 site), *Cecilioides* sp. (1 site), *Rumina decollata* (L.) (1 site), ‘*Helicella*’ spp. (4 sites) and *Sphincterochila* cf. *candidissima* (Draparnaud) (4 sites).

Of the 29 sites in Morocco, 19 were from fissure fill deposits. These were usually found on low crags with rocky slopes beneath (25); mainly either of sandstone (16 sites) or calcareous sandstone (11). In a few cases the fossils were found stratified in wadi-bed deposits (3) or in fissures on low rocky slopes (2). The present vegetation cover in these regions was predominantly sparse to very sparse herbs with some grasses and in a few cases sparse bushes. Only one site had no vegetation today. The elevation of the sites ranged from 75 to 1525 m A.S.L. although the majority of them were over 500 m. The associated faunas included *Granopupa granum* (4 sites), *Cecilioides* sp. (3), *Rumina decollata* (18), ‘*Helicella*’ spp. (14), *Sphincterochila* spp (8), *Massylaea* spp. (5) and *Eremina dillwyniana* (Pfeiffer) (3).

PALAEOENVIRONMENTAL INTERPRETATION

Most of the sites where *Pupoides coenopictus* was recorded were from fissure fills on low crags. Hence it is likely that the species was living in the manner described by Hutton rather than that described by Verhaeghe. This is supported by the associated fauna which included *Granopupa granum*, a species commonly found on rock crags and in the leaf litter associated with rock ledges and crevices on rocky slopes (Gittenberger 1973, Kerney & Cameron 1979). The other species are all commonly found today on rocky slopes. Some of them favour sites under large stones (*Granopupa granum*, *Zootechus insularis*, *Cecilioides* sp., *Rumina decollata*, ‘*Helicella*’ spp.) whilst others are found on the rocks (*Sphincterochila* sp. and *Eremina* sp.). Species from the genus *Massylaea* are often found on rock crags and aestivate deep in rock cracks.

The current knowledge of Quaternary palaeoenvironments in this region is somewhat limited. Most of the data has come from pollen analysis. There are inherent problems with interpreting such records as it is difficult to establish the extent to which long distance transport of pollen grains contributes to the regional pollen spectrum. The data so far suggests that there has been a history of desert expansion and contraction in the last 40,000 years. Rognon (1987) suggests that for the W. part of the Sahara the following sequence is probable:

TABLE 1

Years B.P.	Climate	Soils	Events in the Sahara
2000	Dry	Black paleosol	Start of global cooling
5000	Wet		Thermal optimum
10,000	Dry	Brown paleosol	Desert reaches maximum extent at c. 12 Ka
14,000	Climatic instability		S. edge of Sahara dries rapidly in period 18–20 Ka
20,000	Climatic deterioration	Reddish paleosol at 17–22 Ka	
30,000	Pluvial	Reddish paleosol at 28–30 Ka	Sahara reduced in extent due to increasing lake sizes during pluvial period 30–40 Ka
– 40,000			

In NW. Sahara the record of events is very limited. Andres (1977) suggested that the red soils of the Jbel Bani provide evidence of a humid period with slope stability. Subsequently he identifies two periods of erosion at about 13,000 years and 11–10,000 years BP. Rognon (*op. cit.*) comments that these are likely to be associated with the increasing aridity of the climate.

Most of our records of *Pupoides coenopictus* came from fissure fills which were intensely reddened. The reddening suggests that it is likely that these were deposited at a time when climates were more humid than at present. Given the framework outlined above the most recent period with suitable conditions was prior to 14,000 years BP. At the crags near Figuig, Boudenib and Smara, fissure fill deposits were eroding out onto the underlying slopes; on these slopes further shells were found along with chert which provide evidence of human activity. The chert pieces have been analysed by A. Roberts at the British Museum who provides the following comments:

“Near Smara in Western Sahara one piece of chert is a bladelet with truncation. This type of bladelet is most typical of the Late Palaeolithic to Epipalaeolithic period (c. 20,000 to 10,000 years BP); comparison with other sites in the region with similar materials suggests that this bladelet could have been manufactured in the later phase of these periods, possibly between 14,000 years and 10,000 years BP. Other pieces are less diagnostic, with types of working seen from Late Palaeolithic to Early Neolithic (20,000 to 8,000 years BP), but all types could have been present in the same period as the piece from Smara.”

These implements are thus likely to date from a slightly later period to that inferred for the formation of the fissure fill deposits on lithostratigraphic grounds. It is possible that the fissure fills containing the shells were deposited in humid conditions at prior to 17,000 years BP. This may have been followed by a period with instability where material was eroded out from these deposits onto the slopes below where the Palaeolithic implements were found.

Most of the sites were exposed on slopes where there was evidence of erosion continuing today. There appeared to have been a blanket of sand banked against many of the sites on low crags. This type of banking is also reported from Jbel Bani and Atlas Saharien (Amara 1977), where valleys were completely blocked by sand dunes during a period of erosion associated with increased aridity. In Atlas Saharien (at Bou Saada) these erosional events have been dated at around $13,100 \pm 250$ years BP (^{14}C dating on shells).

The distribution of *Pupoides coenopictus* is most extensive in tropical regions with main centres in Asia and tropical Africa (south of the Sahara). In NW. Africa it appears to have reached the northern limit of its range at the Jbel Bani, Atlas Saharien and getting into the foothills of the Haut-Atlas. To have reached these regions it is likely to have spread northwards or westwards through the rocky regions of the Sahara. It is most likely to have expanded during a more humid phase with mediterranean vegetation occupying a greater area on the margins of the Sahara and when the Sahara itself was narrower than today. Given the evidence from lithostratigraphy and palaeolithic implements it is likely that this expansion took place prior to 14,000 years. Subsequently as the climate became drier at about 13,000 years widespread erosion led to high mobility of sand dunes at the edge of the Sahara. It is possible to speculate that conditions became unsuitable for *Pupoides coenopictus*, hence the shells became preserved in fissure fills on the crags where it was living. The sand banked up against these crags led to the protection and preservation of fossil material.

FACTORS INFLUENCING THE RANGE OF *PUPOIDES*

Pupoides coenopictus is one of few Afro-tropical species which reached the northern Sahara during the late Quaternary. Most of the Magreb molluscs come from an European fauna.

The other species with an Afro-tropical distribution, *Zootechus insularis* was not recorded reaching the present northern limit of the Sahara (Pallary 1934, Seddon & Holyoak unpublished data). It is obvious from the data presented that during the late Quaternary the range of *Pupoides* was more extensive than at present in NW. Africa. Reconstructions of climatic patterns of the region suggest that changes in the position of centres of high pressure and increased rainfall allowed the expansion of vegetation into areas which are now desert (Rognon 1987). These conditions may have been more suitable for *Pupoides coenopictus*.

There was no evidence of living *Pupoides coenopictus* at any of the sites at the northern edge of the Sahara, although live material of other associated Northern Palaearctic species was found at some of the sites. Hence, the conditions today on these crags are apparently unsuitable for *Pupoides coenopictus*. One of the factors which may have limited the northward extension of *Pupoides coenopictus* is frost-sensitivity. Most of the areas in Africa where *Pupoides coenopictus* is found today do not have frequent overnight frost. In these regions of Morocco and Algeria during the winter there are some widespread ground frosts, particularly at higher elevations. The evidence from pollen records from Morocco (Lamb 1988, Rognon 1987) suggest that it is unlikely that low precipitation provided the limiting factor. Our distribution records show that *Pupoides* extended into the edge of the mountain ranges (such as the Haut-Atlas and well into the Saharan Atlas) where precipitation rates increase northwards from the edge of the Sahara. In the last 5000 years precipitation rates have been variable and during some periods were higher than today. Given that associated species such as *Granopupa granum* are found living across the southern parts of the Haut-Atlas and into the Atlas Saharan it seems more likely that temperature provides the limiting conditions for the northern extensions of *Pupoides coenopictus*.

ACKNOWLEDGEMENTS

Thanks are due to: Dr. D. T. Holyoak for his enthusiastic involvement in the project during 1984–1989, numerous discussions and assistance with literature; Romy MacCarthy for translating literature; The Leverhulme Trust for grant aid allowing the continuation of the project; Mr. M. Holyoak for field assistance; Dr. P. G. Oliver, I. J. Killeen and an unknown referee for comments on the manuscript; Cheltenham & Gloucester College of Higher Education, University of Nottingham and Nuffield Foundation for providing facilities in the early stages of the project and the National Museum of Wales for logistical support throughout the project.

REFERENCES

- AMARA, A., 1977. Le gisement Es Sayer Bou-Saada (Algeria). *Libyca, Algiers*, **25**: 59–71.
- ANDRES, W., 1977. Studien zur jungquaternen Relief-entwicklungen des sudwestlichen Anti-atlas und seines sahrischen Vorlandes (Marokko). *Mainzer Geogr. Stud.*, **9**, 147 pp.
- BAKER, H. B., 1935. Review of the anatomy of Pupillidae and related groups. In Pilsbry, 1935 *Manual of Conchology*. 2nd ser., *Pulmonata*, **28**. *Geographic distribution of Pupillidae*, Academy of Natural Sciences of Philadelphia. pp. iv. + 254, 24 pl.
- BAR-YOSEF, O., BELFER-COHEN, A., GOREN, A., HERSHKOVITZ, I., ILAN, O., MIENIS, H. K. & SASS, B., 1986. Nawamis and Habitation sites near Gebel Gunna, South Sinai. *Israel Exploration Journal*, **36**: 121–147.
- BOURGUIGNAT, J.-R., 1876. *Species novissimae Molluscorum in Europaeo systemati detectae, notis diagnosticis succinctis breviter descriptae*. Lutetiae, Bouchard-Huzard. 80 pp.
- , 1883. Histoire malacologique de l'Abyssinie. *Ann. Sci. nat., Paris*, **15**: 47–162.

- FISCHER-PIETTE, E., 1949. Mollusques terrestres et fluviatiles subfossiles récoltés par Th. Monod dans le Sahara occidental. *J. Conchyl., Paris*, **42**: 231–239.
- , 1950. Au sujet de la répartition de *Pupoides coenopictus* Hutton. *J. Conchyl., Paris*, **90**: 221.
- GERMAIN, L., 1930, 1931. *Mollusques terrestres et fluviatiles. Faune de France*, **21, 22**. Paul Lechevalier, Paris.
- GITTENBERGER, E., 1973. Beiträge zur Kenntnis der Pupillacea. III. Chondrininae. *Zool. Verh., Leiden*, **127**: 1–267.
- GROH, K., 1983. Revision der Land- und Süßwassergastropoden der Kapverdischen Inseln. *Arch. Molluskenk.*, **113**: 159–223.
- HUTTON, T., 1834. On the land-shells of India. *J. asiat. Soc. Beng.*, **3**: 85–93.
- KERNEY, M. P. & CAMERON, R. A. D., 1979. *A Field Guide to the Land Snails of Britain and north-west Europe*. Collins, London.
- LAMB, H. F., EICHER, U. & SWITSUR, V. R., 1989. An 18,000 year record of vegetation, lake-level and climatic change from Tigalmamine, Middle Atlas, Morocco. *J. Biogeogr.*, **16**: 65–74.
- MIENIS, H. K., 1974. *Pupoides coenopictus* (Hutton, 1834) in Israel. *Basteria*, **38**: 99–100.
- , 1979. A further note on the presence of *Pupoides coenopictus* in the Dead Sea basin. *Levantina*, **23**: 262–263.
- , 1990. Appendix B. The molluscs of site 911 in Biq'at 'Uvdah 'Atiqot, **10**: 9–12.
- MORELET, A., 1848. *Testacea quaedam Africae occidentalis terrestria et fluviatilia Revue Zoologique (Soc. Cuv)* 'Series concholiologiques', **11**: 351–355.
- , 1853. Catalogue des Mollusques terrestres et fluviatiles de l'Algérie. *J. Conchyl., Paris*, **4**: 280–305.
- , 1872. Notice sur les Coquilles Terrestres et d'eau douce recueillies sur les côtes de l'Abyssinie. *Annali Museo Civ. di Storia Nat. di Genova*, **iii**: 180–208.
- PALLARY, P., 1909. Catalogue de la faune malacologique d'Egypte. *Mem. Inst. Egypt.*, **6**: 1–92; **7**: 1–61.
- , 1929. Sur un Bulimini de nouveau du Hoggar. *Bull. Soc. Hist. nat. Afr. N.*, **20**: 6–7.
- , 1934. Mollusques du Sahara Central. (Offprint has numbered pp. 58–72 but no indication of where published; Fischer & Fischer-Piette 1946 give this as *Mem. Soc. Hist. nat. Afr. N.*).
- PILSBRY, H. A., 1920–1921. *Manual of Conchology. 2nd ser., Pulmonata. vol. 26. Pupillidae (Vertigininae, Pupillinae)*. Academy of Natural Sciences of Philadelphia. pp. iv. + 254, 24 pl.
- ROGNON, P., 1987. Late Quaternary climatic reconstruction for the Magreb (North Africa). *Palaeogeography, Palaeoclimatology, Palaeoecology*, **58**: 11–54.
- SHILEYKO, A. A., 1984. [*Mollusca, Gastropoda, Pulmonata, Geophila, Fauna USSR. New Series*], no. 130. 399 pp., 279 Figs. (in Russian).
- STARMÜHLER, F. & EDLAUER, A., 1957. Beiträge zur Kenntnis der Molluskenfauna des Iran. *Sber. ost. Akad. Wiss.*, **166**: 435–494.
- VERHAEGHE, M.A.P., 1983. Quelques sites malacologique dans l'Air, République du Niger. *Arion*, **8**: 3–12.
- WOLLASTON, T. V., 1878. *Testacea Atlantica, or the land and freshwater shells of the Azores, Madeiras, Salvages, Canaries, Cape Verdes, and Saint Helena*. L. Reeve & Co., London.

PLENTUISA VENDIA, A NEW GENUS AND SPECIES FROM THE PICOS DE EUROPA (NORTH OF THE IBERIAN PENINSULA) (GASTROPODA: HELICOIDEA: HYGROMIIDAE)

A. I. PUENTE¹ AND C. E. PRIETO¹

(Accepted for publication, 21st March, 1992)

Abstract: A new genus of Hygromiidae, *Plentuisa*, is described for *P. vendia* n. sp., discovered in the Picos de Europa (Asturias, North of the Iberian Peninsula), and characterized by a very small shell with long hairs, widely umbilicate, and a genital system with a male portion having a rudimentary flagellum and a female portion having digitiform glands but lacking dart and accessory sacs. The systematic position of the new genus is discussed, and it is included in the subfamily Trichiinae.

INTRODUCTION

The Iberian Peninsula is one of the most poorly studied areas in Europe as far as its malacological fauna is concerned; however, it is an area of considerable interest due both to the great number of species it contains, with well defined distribution patterns, and to the singular nature of some of these species. During a systematic faunistic study of land molluscs in the northern Iberian Peninsula, we found specimens of a new species in the Picos de Europa (Asturias), for which a new genus is described.

PLENTUISA n. gen.

Description

Shell: very small, hairy, brown in colour, depressed above, convex below, with a spire of $4\frac{1}{4}$ – $4\frac{3}{4}$ whorls increasing slowly and regularly; last whorl non descending towards the aperture. Umbilicus deep and wide, and approximately $\frac{1}{4}$ of the maximum shell width. Aperture round, with a strong, deep internal lip; non-thickened peristome, slightly reflected at the columellar edge.

Genitalia: characterized by a short, thickened vagina with no dart sacs or accessory sacs, surrounded by four digitiform mucous glands. Bursa copulatrix, located next to the spermoviduct, round or transversely oval; bursa copulatrix duct of medium length. Penis wide and cylindrical; penial papilla with an apical aperture and, in transverse section, a central canal, without lacunae. Epiphallus twice as long as the penis, and thinner. Flagellum rudimentary. Right ommatophore retractor does not cross the genital ducts. Penial nerve apparently originated from the right cerebral ganglion.

¹ Animali Biologia eta Genetika Departamentua, Universidad del País Vasco/Euskal Herriko Unibertsitatea, Posta-Kutxa: 644, 48080-Bilbao, Spain.

Derivatio nominis. The name *Plentuisa* is an allusion to a barbarian people who lived in the mountain regions between the headwaters of the Rivers Ebro and Deva, the Plentuisi (Estrabon, 3,3,8), and who apparently successfully resisted Roman domination.

Type species:

PLENTUISA VENDIA n.sp.

(Figs. 1–7, 10–18)

Trichia (Trichia) hispida, Haas 1935. *Senckenbergiana*, **17**: 243 (non Linnaeus, 1758).

Description

Shell (Figs. 10–15): very small, depressed above and convex below. Spire of $4\frac{1}{4}$ to $4\frac{3}{4}$ whorls slowly and regularly growing, separated by deep sutures. Last whorl non descending at the aperture. Umbilicus deep and wide, approximately $\frac{1}{4}$ of the maximum shell diameter. Aperture rounded, with converging marginal edges and a strong deep-set internal lip, visible from the outside as a yellowish or whitish area. Non-thickened peristome, slightly reflected at the columellar edge. Shell thin, translucent and brown in colour, without bands. Periostracum with relatively long, persistent hairs (more than 0.5 mm) which are thin and widened at the base, and cover the whole surface of the shell. There is a shallow longitudinal striation on the teleoconch on which a microsculpture of small crests is found in an irregular spiral layout. Protoconch without peculiar characteristics.

Dimensions: maximum diameter = 4.2–5.2 mm; height = 2.2–2.8 mm.

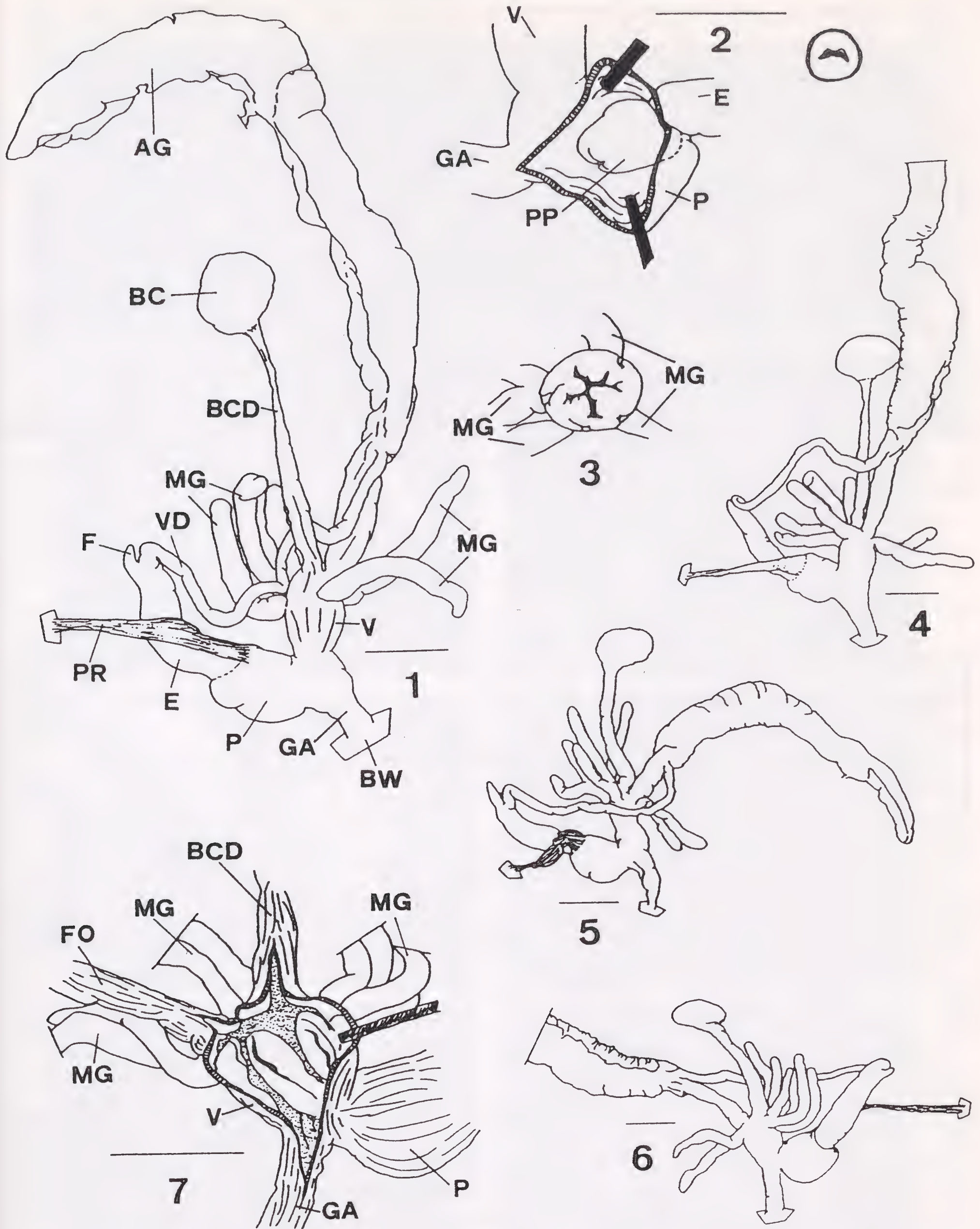
Body: white, with a small number of disperse, irregularly shaped, black spots on the surface of the mantle.

Jaw (Fig. 16): arched, with approximately 13 shallow ribs which cause the concave edge to be slightly toothed.

Radula (Figs. 17–18): tricuspid central tooth with highly developed mesocone; 9–10 bicuspid lateral teeth with a strong, pointed mesocone and a shorter, robust ectocone; 7–8 marginal teeth with the ectocone divided into 2–3 small points. From tooth 13 or 14 onwards, the mesocone is also bifurcate.

Genitalia (Figs. 1–7): cylindrical penis of similar width throughout its length, though it may become slightly slimmer towards the genital atrium. Epiphallus approximately twice as long and half as wide as the penis. Flagellum very short, rudimentary, thick and conical. Penis retractor muscle very variable in length, though generally long, and widened at its joint with the penial complex; in some specimens dissected it appears to embrace the distal part of the epiphallus. Internal part of the penis with an elongated penial papilla, with an apical aperture, traversed by a central canal and, in transverse section, without lacunae. Genital atrium long and thin. Vagina as long or longer than the penis. There are no dart sacs or accessory sacs, though in the proximal part and around the vagina there are four highly developed mucous glands, single or forked from the base. Internal surface of the vagina with four double longitudinal folds placed below the insertion of the mucous glands, which flow behind the upper ends of the two pairs of vaginal folds. Bursa copulatrix rounded or transversely oval; its width is from $\frac{1}{2}$ to $\frac{1}{3}$ of the length of the bursa copulatrix duct. Free oviduct length half that of the bursa copulatrix duct.

Derivatio nominis. The name *vendia* refers to the name presumably given to the Picos de Europa by Pliny, “mons Vendius” (Pliny 3,6).



Figs. 1–7: *Plentuisa vendia* n.gen., n.sp.: 1 – External morphology of the genital system of the holotype (Sotres, Asturias). 2 – Penial papilla and its transverse section (holotype). 3 – Transverse section of the vagina and disposition of mucous glands (holotype). 4 – External morphology of the genital system of a paratype from Sotres. 5 – External morphology of the genital system of a paratype from Tielve. 6, 7 – External morphology of the genital system and longitudinal section through the vagina of a paratype from Sotres. Scale: 1 mm. Abbreviations: AG: albumen gland, BC: bursa copulatrix, BCD: bursa copulatrix duct, BW: body wall, E: epiphallus, F: flagellum, FO: free oviduct, GA: genital atrium, MG: mucous glands, P: penis, PP: penial papilla, PR: penial retractor, V: vagina, VD: vas deferens.

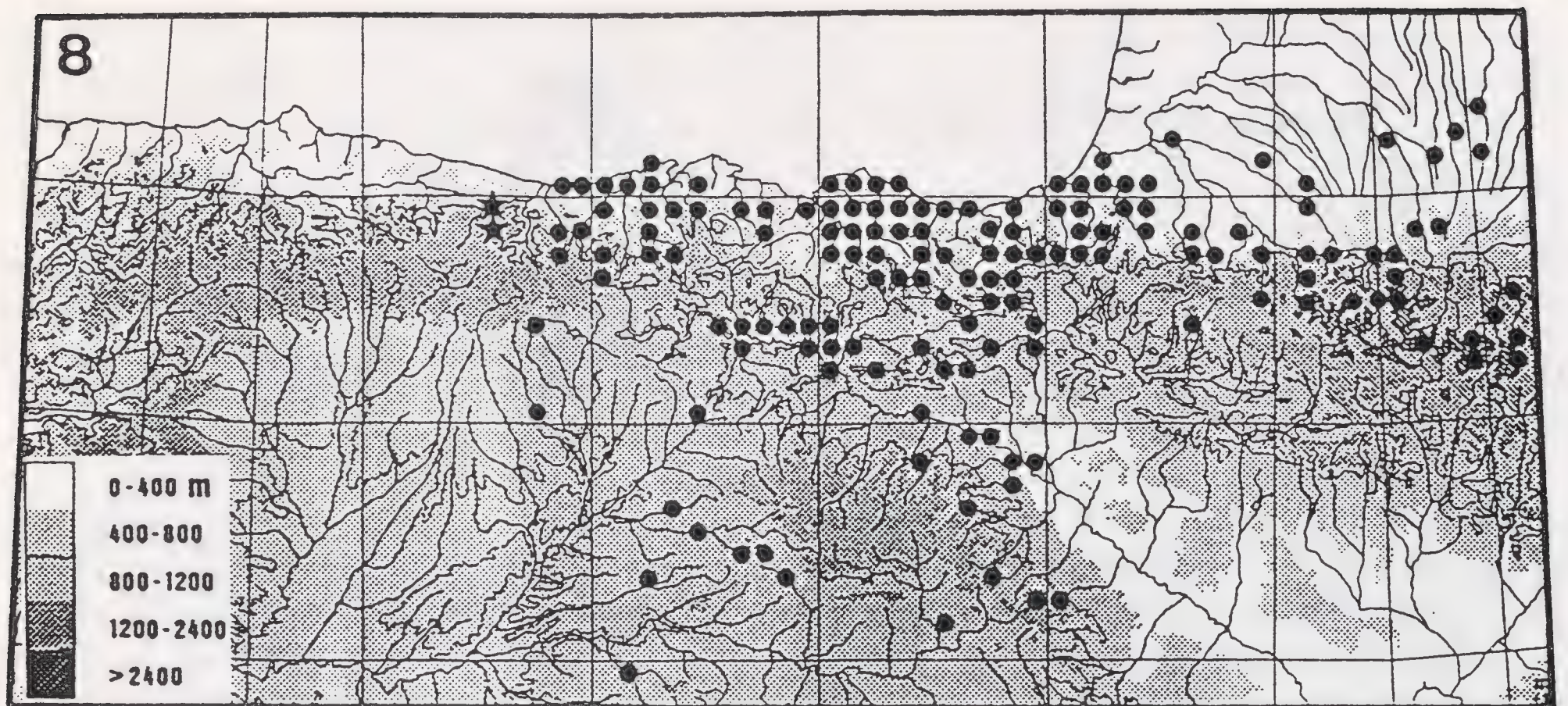


Fig. 8. Geographical distribution in the centre of the northern third of the Iberian Peninsula of *Trichia hispida* (circles) and *Plentuisa vendia* n. gen., n. sp. (stars), in UTM notation of 10 km $\times$ 10 km squares.

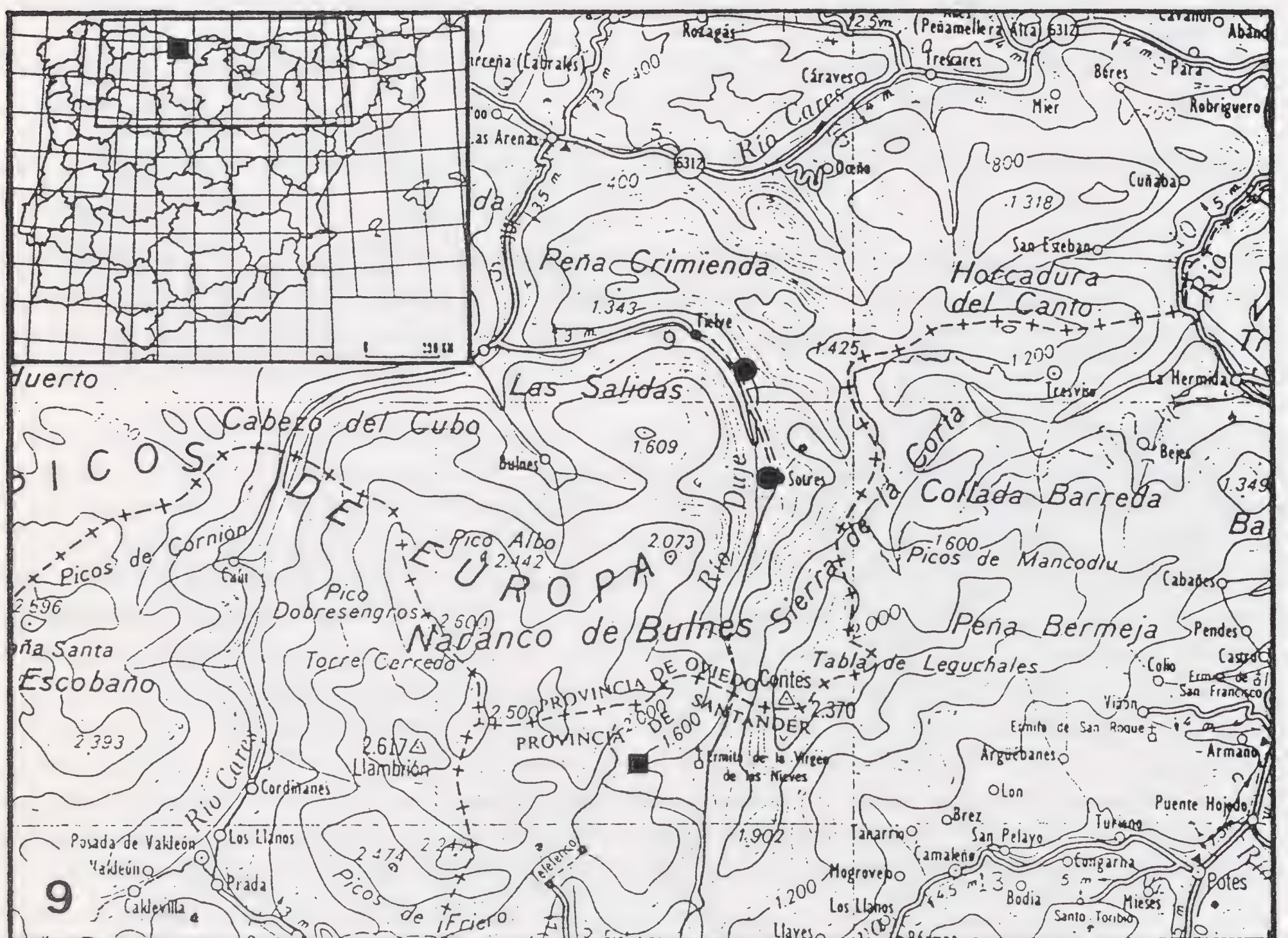
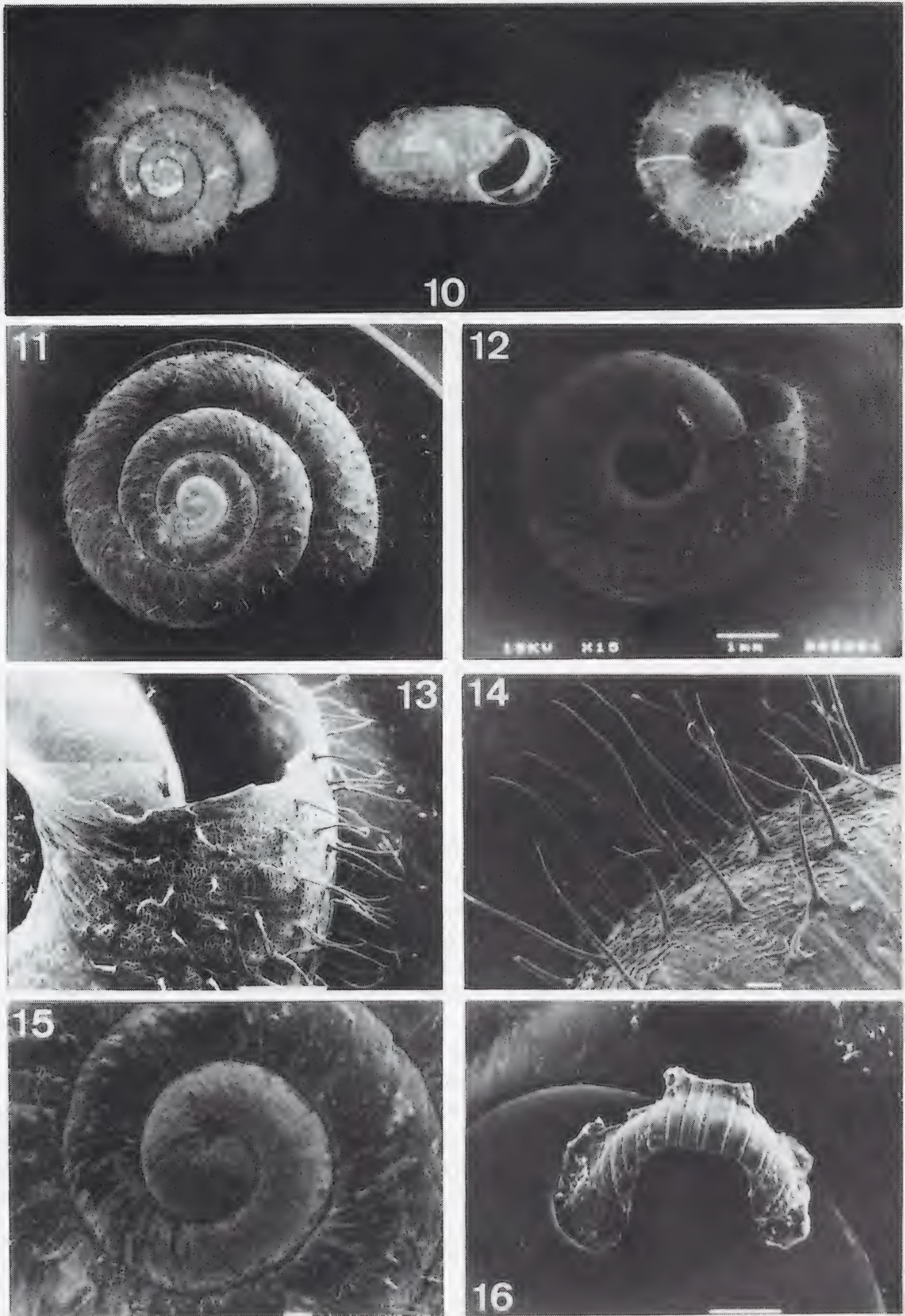
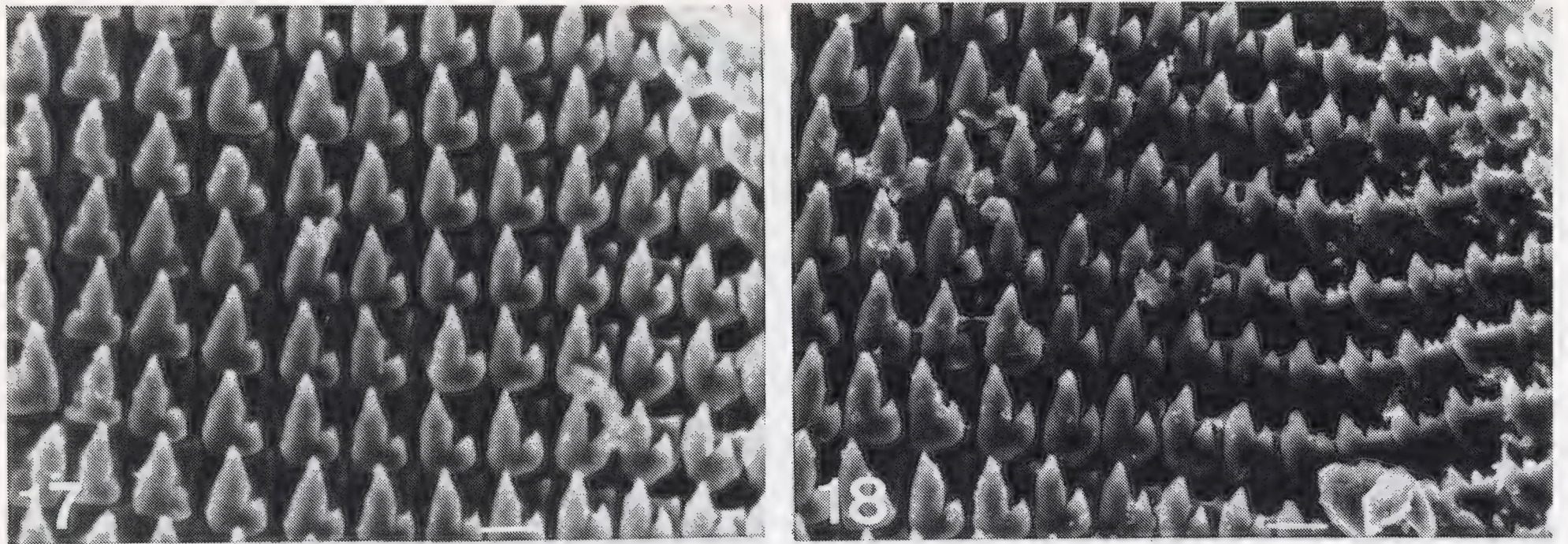


Fig. 9. Detail of the distribution of *Plentuisa vendia* n. gen., n. sp. in the Picos de Europa (circles) showing the location indicated for *Trichia hispida* by Haas (1935) (square).



Figs. 10–16. *Plentuisa vendia* n. gen., n. sp.: 10 – Top, side and bottom views of the shell (5.5×) 11,12 – Top and bottom views of others specimens (both 15×) 13 – Bottom surface of shell next to aperture (50×, scale: 500 μ m). 14 – Microsculpture of shell and detail of hairs (100×, scale: 100 μ m). 15 – Protoconch (75×, scale: 100 μ m). 16 – Jaw (200×, scale: 100 μ m).



Figs. 17–18. *Plentuisa vendia* n. gen., n. sp.: 17 – Central and lateral teeth. 18 – Lateral and marginal teeth. Both 1000×, scale: 10 µm.

Typical series

Holotype: Sotres (Asturias), 30T UN578882, 980 m, leg. K. Altonaga, R. Gorrotxategi, C. E. Prieto and A. I. Puente, 16.XI.90 (Euskal Herriko Unibertsitatea, Zoology laboratory).

Paratypes: Sotres (Asturias), collected with holotype (EHU/Z: 21 specimens and 81 shells; SMF, Frankfurt: 1 sp. and 2 sh.; Rijksmuseum, NHM, Leiden: 1 sp. and 2 sh.; MNHN, Paris: 1 sp. and 2 sh.; BM (NH), London: 1 sp. and 2 sh.; NHM, Wien: 1 sp. and 2 sh.; MZ, Barcelona: 1 sp. and 2 sh.; MNCN, Madrid: 1 sp. and 2 sh.). Sotres (Asturias), 30T UN578882, 980 m, leg. B. Gómez, 20.IX.88 (EHU/Z: 1 sp. and 10 sh.). Tielve (Asturias), 30T UN571905, 760 m, leg. B. Gómez, R. Gorrotxategi and J. M. Ruiz de la Rosa, 20.IX.88 (EHU/Z: 3 sp. and 7 sh.). Sotres (Asturias), 30T UN578882, 980 m, leg. A. Prieto, 17.X.91 (EHU/Z: 1 sp. and 40 sh.).

Habitat and geographical distribution (Figs. 8–9). *P. vendia* n. gen., n. sp. seems to be limited to the western massif of the Picos de Europa. The only known localities are concentrated on the valley of the River Duje, a small tributary of the Cares. It lives on exposed biotopes, on limestone substrates and at the foot of the vegetation which grows in the cracks in rocks. At both Sotres and Tielve the following species were also found: *Obscurella bicostulatum* (Gofas), *O. hidalgoi* (Crosse), *Pomatias elegans* (O. F. Müller), *Pyramidula rupestris* (Draparnaud), *Abida vasconica* (Kobelt), *Chondrina kobelti* (Westerlund), *Lauria cylindracea* (da Costa), *Pupilla muscorum* (Linnaeus), *Vallonia costata* (O. F. Müller), *Helicella itala* (Linnaeus) and *Oestophorella buvinieri* (Michaud); also, at Sotres, *Vallonia excentrica* Sterki, *Arion intermedius* Normand, *Vitrea contracta* (Westerlund) and *Deroceras reticulatum* (O. F. Müller), and at Tielve, *Ceciloides acicula* (O. F. Müller) and *Mengoana brigantina* (Da Silva Mengo).

HAAS (1935) referred two shells “auffallend flache” from the Aliva mountain refuge (30T UN5481) to *Trichia hispida*. These we believe, must be referred to *P. vendia* which has the superficially similar shell, as this area lies outside the distributional area of *T. hispida*, but is less than 10 km from the type locality of *P. vendia* also in the Duje valley (see Figs. 8–9). In any case, the material to which this author referred should be reviewed.

DISCUSSION

The classification system traditionally used for the Helicoidea *s. lat.* (Zilch 1960, Solem 1978, Kerney *et al.* 1983) has been profoundly changed over the last twenty years. Two new

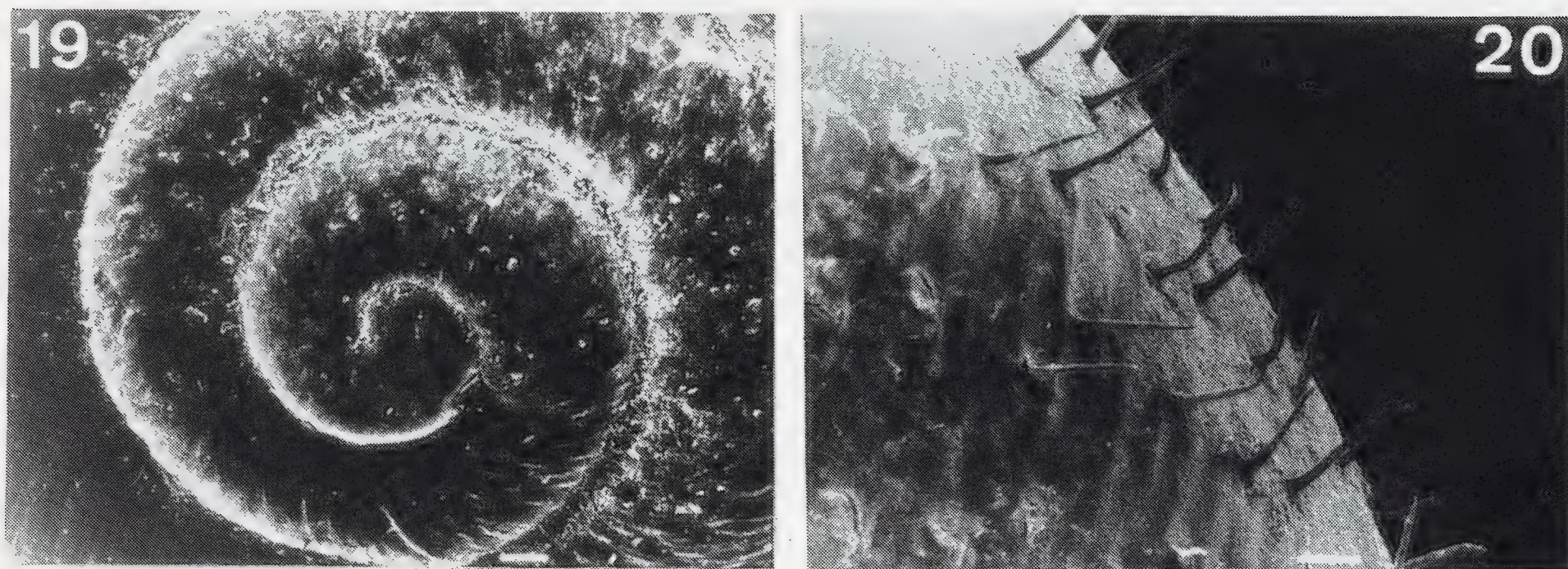
alternative proposals have been put forward; the system proposed by Schileyko (1972, 1973, 1978a, 1978b, 1979, 1991) and that of Nordsieck (1986, 1987). Both classifications coincide largely with regard to the taxonomic characters used to describe higher categories (e.g. configuration and position of the stimulatory apparatus, location of the bursa copulatrix with respect to the spermoviduct, presence or absence of a diverticle of the bursa copulatrix duct, morphology and position of the mucous glands), but they differ in the configuration of the plesiomorphic status. Another point of disagreement between these two classificatory schemes lies in the interpretation of the dartless sac (inner sac) of the stimulatory apparatus in the Hygromiidae *sensu* Nordsieck (Hygromioidea *sensu* Schileyko). While Schileyko and other authors (Giusti & Manganelli 1989b: 51) consider it a modified dart sac, which remains as a useless vestigial structure, Nordsieck (1987) and Hausdorf (1988) consider it as a reservoir, non homologous to the dart sac, for the secretion from the mucous glands (= accessory sac). Our own observations lead us to believe that the latter interpretation is more likely (Prieto & Puente, in press).

On the basis of the characters mentioned in the description, i.e. bursa copulatrix next to the spermoviduct, with duct and without diverticle, digitiform mucous glands, presence of an epiphallus and a true penial papilla, *Plentuisa* n. gen. is included in the Hygromiidae (*sensu* Nordsieck 1987; *sensu* Schileyko 1991). It is not easy, however, to determine the subfamily in which the new genus should be placed.

In Nordsieck's (1987) classification system, the Hygromiidae are divided into seven subfamilies, mainly on the basis of the number and morphology of their dart sacs and accessory sacs and the morphology of the dart. For subdivision into tribes, other characters have also been considered, such as presence or absence of mucous glands, position of the right ommatophore retractor muscle and, sometimes, geographical distribution. According to Nordsieck's (1987) scheme, *Plentuisa* could only be placed amongst the Monachinae: Monachini, next to *Ashfordia* Taylor, *Szentgalia* Pinter and *Metatheba* Hesse, which are characterized by their possession of a reduced stimulatory apparatus. However, the absence of mucous glands in both *Ashfordia* and *Szentgalia* (Pinter 1977) differentiate these genera from *Plentuisa*. *Metatheba*, which does have mucous glands (Hudec 1973, Gittenberger & De Winter 1985, Schileyko 1978b: Figs. 377–378), differs from *Plentuisa* in that its shell is much larger, globular, its umbilicus is very narrow and its shell-surface finely striated and hairless, while its genital apparatus has a large vagina with two branched mucous glands, a well developed flagellum, a muscular band between atrium and penis, and a cylindrical penial papilla showing in transverse section a circular cavity around the central duct.

On the other hand, according to the subfamily diagnosis of Hygromiidae by Schileyko (1991), *Plentuisa* could be placed in the Euomphaliini tribe of Euomphaliinae (*nomen novum pro* Monachinae; = Monachini plus Euomphaliini *sensu* Nordsieck, except *Hesseola* Lindholm and *Paedhoplita* Lindholm, which for Schileyko have their own subfamily status).

However, this systematic position of *Plentuisa* is, in our opinion, incorrect. Giusti & Manganelli (1987, 1989a), Manganelli & Giusti (1988) and Manganelli *et al.* (1989) indicated that genital ducts without any of the various accessory vaginal organs could have evolved in parallel from different ancestral situations; hence the difficulty in identifying higher categories for recently described genera which, like *Plentuisa*, lack a complete stimulatory apparatus. In these cases, other characters have been considered in an attempt to classify them. These include the internal morphology of the vagina and the structure of the penial papilla. In this way, *Plentuisa*, which has four longitudinal intravaginal folds beginning at the point of implantation of the mucous glands in the position which would be occupied by the absent sacs, could be related to the genera equipped with a double stimulatory apparatus, i.e. Trichiinae, a subfamily characterized by having two dart sacs, each with its corresponding accessory sac, and each with its corresponding two folds on both sides of internal surface of vagina, and which includes two tribes differentiated by the



Figs. 19–20. *Trichia (Trichia) hispida* (L., 1758) from Hacias (Burgos, 30T VM748476, 1000 m): 19 – Protoconch (75 $\times$, scale: 100 μ m). 20 – Microsculpture of shell and detail of hairs (100 $\times$, scale: 100 μ m).

different position of the right ommatophore retractor (between penis and vagina in Trichiini and free in Helicellini) (1). The disposition of the vaginal folds in *P. vendia* is similar to that observed in various genera of Trichiini (see Schileyko 1978a). In *Plentuisa*, the disappearance of the sacs with retention of mucous glands would have led to the redistribution of the folds inside the vagina.

As regards the shell, *Plentuisa vendia* n. sp. recalls *Trichia hispida* (Figs. 19–20), the only species of the *Trichia s.lat.* group present in the Iberian Peninsula: both have depressed, thin, translucent shells of a horny colour, a wide umbilicus (wider in *P. vendia*), a whitish internal area (highly thickened in *P. vendia*), and long, thin hairs (longer in *P. vendia*). Similar shells (small, depressed, widely umbilicated and hairy) are found, though banded, in the genus *Xerotricha* Monterosato (which, according to Giusti & Manganelli 1989b, includes *Xeromicra* Monterosato), which is very diversified in the northern Iberian Peninsula. Anatomically, *P. vendia* differs from *T. hispida*, not only in the absence of dart and accessory sacs and a free right ommatophore retractor, but also in having a very short flagellum and a penial papilla without lacunae. The transverse section of the *P. vendia* penial papilla recalls the one proposed by Schileyko (1978a) as corresponding to the ancestral form of the *Trichia s.lat.* group. On the other hand, similar penial papillae are found in other species included in the Helicellini, e.g. *Xerotricha apicina* (Lamarck) and *Helicella itala* (Linnaeus) (Giusti & Manganelli 1989b).

Nordsieck (1987) also includes in the Trichiini the genus *Ponentina* Hesse, monotypical for *P. subvirescens* (Bellamy), a species living in the western half of the Iberian Peninsula, Brittany and SW. England. Its shell also has long thin hairs but, among other differences, it is more globular than that of *P. vendia*, larger, with a greatly inflated last whorl and very narrow umbilicus. Anatomically, *P. subvirescens* has two dart sacs, with darts (Manga 1983: Fig. 50, Castillejo 1986: Lám. XII, Fig. A), and two accessory sacs in which the mucous glands, generally bifurcated from the base, are inserted; the penis is widened due to the large penial papilla, which is spoon-shaped with a central crest in the concavity; the flagellum is as long as the epiphallus and thicker at the centre, ending in a blunt, arched tip (Prieto 1986: Fig. 49). In our opinion, the systematic position of *Ponentina* is very problematical: effectively, the presence of a double stimulatory apparatus with accessory sacs indicates a possible relationship to Trichiinae, although the position of the mucous glands on the accessory sacs; and not on the vagina, and the absence of vaginal folds (unpublished observations) would separate it from the rest of the Trichiinae as a proper subfamily, as proposed Schileyko (1991), although incorrectly characterized.

In our opinion, *Plentuia* could have derived from the line which produced the SW European 'Helicellini' group (*Helicella*, *Xerotricha*, *Candidula*), once the free position of the right ommatophore retractor was acquired, by means of the loss of the sacs and greater development of the intravaginal folds to conduct the mucous secretion, with certain ancestral characters being retained, such as the general appearance of the shell (hairy, brownish, unbanded) and a penial papilla with solid walls, character considered by Schileyko (1978a) as primitive for 'Trichiini'.

In any case, if we admit that *Plentuia* belongs to the Trichiinae, we prefer not to include the new genus in either of the two tribes described until the value of the characters used be determined. Although we consider the phylogenetic scheme of the Hygromiidae proposed by Nordsieck (1987) to be more appropriate, we believe that the two classifications recently proposed are to some extent artificial, since the uncertain status of certain taxa has been resolved by creating others on a higher level to accommodate them. They are becoming more and more unpredictable as observations become more numerous and accurate; the following genera have recently been included in Hygromiidae as *incertae sedis*: *Montserratina* Ortiz de Zárate (Giusti & Manganelli 1989a), *Thyrreniella* Giusti & Manganelli (Giusti & Manganelli 1989b), and *Schileykiella* Manganelli, Sparacio & Giusti (Manganelli *et al.* 1989), the latter was recently included by Schileyko (1991) in Ciliellidae: Ciliellinae.

ACKNOWLEDGEMENTS

We wish to express our gratitude to Dr. J. Moya for his valuable suggestions on naming the species and to Dr. B. Gómez for his collaboration in photographing the material. Also Dr. F. Giusti for his interesting comments and criticisms of an earlier manuscript. This research was supported by projects X-86.044 of the Department of Education, Universities and Research of the Basque Government and PB88-0397 of the Spanish General Directorate for Scientific and Technical Research (DGICYT).

REFERENCES

- CASTILLEJO, J., 1986. Caracoles terrestres de Galicia. Familia Helicidae (Gastrópoda, Pulmonata). *Monogr. Univ. Santiago de Compostela*, **122**: 1-65.
- GITTENBERGER, E. & DE WINTER, A. J., 1985. A Pyrenean *Monacha* species, *Monacha* (*Metatheba*) *atacis* spec. nov. (Mollusca: Gastropoda: Pulmonata). *Zool. Med. Leiden*, **17**: 197-207.
- GIUSTI, F. & MANGANELLI, G., 1987. Notulae Malacologicae, XXXVI. On some Hygromiidae (Gastropoda: Helicoidea) living in Sardinia and in Corsica. (Studies on the Sardinian and Corsican Malacofauna VI). *Boll. malac.*, **23**: 123-206.
- , 1989a. *Montserratina* Ortiz de Zárate López, 1946 (Pulmonata: Hygromiidae): a redescription. *Iberus*, **8** (1): 89-100.
- , 1989b. Notulae Malacologicae, XLIV. A new Hygromiidae from the tyrrhenian islands of Capraia and Sardinia with notes on the genera *Xeromicra* and *Xerotricha* (Pulmonata: Helicoidea). (Studies on the Sardinian and Corsican Malacofauna, VIII). *Boll. malac.*, **25**: 23-62.
- HAAS, F., 1935. Zur Mollusken-Fauna der Picos de Europa (Asturien, Spanien). *Senckenbergiana*, **17**: 241-243.
- HAUSDORF, B., 1988. Zur kenntnis der systematischen Beziehungen einiger Taxa der Helicellinae Ihering 1909 (Gastropoda: Hygromiidae). *Arch. Molluskenk.*, **119** (1/3): 9-37.
- HUDEC, V., 1973. Helicidae (Gastropoda, Pulmonata) gesammelt von der niederländischen biologischen Expedition in die Türkei in 1959. II. *Zool. Meded.*, **46** (18): 231-259 + taf. 1.
- KERNEY, M. P., CAMERON, R. A. D. & JUNGBLUTH, J. H., 1983. *Die Landschnecken Nord- und Mitteleuropas*. Ed. P. PAREY, Hamburg und Berlin. 384 pp.
- MANGA, M. Y., 1983. *Los Helicidae (Gastropoda, Pulmonata) de la provincia de León*. Ed. Diputación Provincial de León, Inst. "Fray Bernardino de Sahagún", León. 394 pp.

- MANGANELLI, G. & GIUSTI F., 1988. Notulae Malacologicae, XXXVIII. A new Hygromiidae from the Italian Apennines and notes on the genus *Cernuella* and related taxa (Pulmonata: Helicoidea). *Boll. malac.*, **23**: 327–379.
- , SPARACIO, I. & GIUSTI, F., 1989. New data on the systematics of two sicilian land snails, *Helix parlatoris* Bivona, 1839 and *Helix reinae* L. Pfeiffer, 1856 and description of *Schileykiella* n.gen. (Pulmonata: Hygromiidae). *J. Conch., Lond.*, **33**: 141–156.
- NORDSIECK, H., 1986. Das System der tertiären Helicoidea Mittel-und Westeuropas (Gastropoda: Stylommatophora). *Heldia*, **4** (1): 109–120.
- , 1987. Revision des Systems der Helicoidea (Gastropoda: Stylommatophora). *Arch. Molluskenk.*, **118** (1/3): 9–50.
- PINTER, L., 1977. Studien an *Monacha* (Gastropoda: Helicidae), I. Über die subgenerische Zugehörigkeit von *Monacha gregaria* (Rossmässler). *Arch. Molluskenk.*, **108** (1/3): 53–55.
- PRIETO, C. E., 1986. *Estudio sistemático y biogeográfico de los Helicidae sensu Zilch, 1959–60 (Gastropoda: Pulmonata: Stylommatophora) del País Vasco y regiones adyacentes*. Tesis Doctoral. Universidad del País Vasco. 393 pp. + 10 lám.
- , & PUENTE, A. I., El género *Hygromia* Risso, 1826 en la Península Ibérica, con descripción de *Hygromia gofasi* sp. nov., y consideraciones sobre la interpretación funcional del aparato estimulador de Hygromiidae. *Bull. Mus. Hist. nat. Paris* (in press).
- SCHILEYKO, A. A., 1972. Taxonomical and geographical structure of the tribus Hygromiini Schileyko (Pulmonata: Helicidae). *Zool. Zh.*, **51**: 1129–1141. (in Russian).
- , 1973. Comparative characteristics of the palaearctic families of terrestrial molluscs from the superfamily Helicoidea. *Zool. Zh.*, **54** (4): 492–506. (in Russian).
- , 1978a. On the systematics of *Trichia* s.lat. (Pulmonata: Helicoidea: Hygromiidae). *Malacologia*, **17** (1): 1–56.
- , 1978b. Molluscs. Land molluscs of the superfamily Helicoidea. *Fauna SSSR, (N.S.)*, **17**: 1–384. (in Russian).
- , 1979. The system of the order Geophila (=Helicida) (Gastropoda Pulmonata). *Trans. zool. Inst. Akad. Sci. USSR*, **80**: 44–69. (in Russian).
- , 1991. Taxonomic status, phylogenetic relations and system of the Helicoidea sensu lato. *Arch. Molluskenk.*, **120** (4/6): 187–236.
- SOLEM, A., 1978. Classification of the land mollusca. In V. FRETTER & J. PEAKE (eds.): *Pulmonates*, 2A. *Systematics, evolution and ecology*: 49–97; London.
- ZILCH, A., 1960. Euthyneura. In WENZ, W.: *Gastropoda. Hand. Palaeozool.*, **6** (2, 4th part): 601–835 + I–XII.

NOTE

(1) – According to recent works by Giusti & Manganelli (1987), Hausdorf (1988) and Manganelli & Giusti (1988), all the genera of Hygromiinae: Helicellini *sensu* Nordsieck have accessory sacs. Those genera with double stimulatory apparatus included therein, i.e., *Helicella* Férussac, and *Xerotricha* Monterosato, plus *Candidula* Kobelt (with simple stimulatory apparatus but with rudiments of the second dart sac, Hausdorf 1988), with right ommatophore retractor free of the genital ducts, then fit into the diagnosis of the Helicopsini tribe of Trichiinae, while those which have an assymetric stimulatory apparatus (*Cernuella* Schlüter, *Xerosecta* Monterosato, *Microxeromagna* Ortiz de Zárate) remain in Hygromiinae. Therefore, Helicopsini is synonymous with Helicellini, while the genera of Hygromiinae cited become part of the Cernuellini tribe, as proposed by Schileyko (1991).

THE IDENTITY OF TWO EUCONULOID SNAILS RECENTLY FOUND IN THE SEYCHELLES

B. VERDCOURT¹

(Accepted for publication, 14th December, 1991)

Abstract: Extensive attempts to name two small snails collected in the Seychelles, including anatomical studies, have revealed that one is certainly *Liardetia sculpta* (Möllerndorff) a species known from the Marianas Islands, Caroline Islands and SE. China. It also matches material later described from Mauritius as *Louisia insularis* Godwin-Austen. The other species is almost certainly *Louisia barclayi* (Benson) but the detailed anatomy of that is apparently not known.

INTRODUCTION

As reported some years ago (Verdcourt 1986: 331, fig. 4) Dr. C. Vaucher of the Geneva Museum sent me a small collection of Mollusca from the Seychelles including two specimens of a small species from Côte D'Or, euconuloid in shape, which I was quite unable to name. There the matter rested since I was reluctant to destroy a shell in order to attempt a dissection of the minute retracted animal. Later I met a young resident of the Islands, Justin Gerlach, who, interested in the molluscs, was sure he could find more material. This he did at Le Niol, Mahé on 4th January 1989 but the material was still not really adequate for dissection. He therefore obtained further material from two stations Le Niol and Casse Dent which he handed to me on 19th December 1989. On examination I was most surprised to find two quite different species present, those from Le Niol being the same as the two previous lots but those from Casse Dent differing considerably in having an angled periphery and very much finer striation, very similar to a *Kaliella*. The more strongly striated shell with a rounded periphery is designated species A and the finely striated shell with a angled periphery species B.

HISTORICAL AND DESCRIPTIVE

Von Martens and Wiegmann (1898) recorded a *Kaliella* from the Seychelles, namely *K. subturritula* (G. & H. Nevill) but the figure they give (taf. 2, fig. 14) shows a relatively much taller shell than B with height equalling the breadth. G. & H. Nevill's original description (1871) of *Helix subturritula* is somewhat meagre but adequate although they give no figure. The description does, however, exclude both A and B 'horn-coloured, 7 turrited whorls, distinct suture, no sculpture even under a lens, apex somewhat mamillate, later whorls strongly keeled, base nearly flat, imperforate, aperture angular about as high as broad. It can be distinguished from the Indian species of the same type by its flatter base and less convex whorls, animal black mottled with yellow. Damp ravine, Mahé, 800 ft. 4 × 4.5 mm.' The type is probably in Calcutta.

¹ Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB.

Species A has an essentially rounded shell with no peripheral keel at any stage (Pl. 10A); there are virtually no spiral striae above save on embryo shells and very faint beneath but close. The upper side has close transverse ribs to the extreme apex. There is no caudal tail but an overhanging lobe and a caudal pore. The species is ovoviviparous with numerous or only two or three embryos. The foot is dark with the sole clearly tripartite. The jaw is not angled in the middle. Radula formula: 25–35; 3–5; c; 3–5; 25–35; 3+2 intermediates and outer marginals definitely 3-cusped. Dart a small unguiform thickening inside the base of the penis (Fig. 3). Spermatheca almost round, $\pm$ sessile at junction of male and female ducts or just on the male side. The penial anatomy is very characteristic, particularly the Y-shaped epiphallus (Fig. 2).

Species B has a distinctly keeled shell and there are no spiral striae above. The upper side is very finely transversely striate to the extreme apex (Pl. 10B). There is no caudal tail above the pore. The mantle and upper body are speckled black in a lined pattern. No embryonic shells were observed in several specimens dissected and I believe the species is not ovoviviparous. The foot is creamy white, evidently but not strongly tripartite. The radula has 4 lateral teeth and the marginals are 3–4-fid. The spermatheca (Figs. 5,6) is slender with a very slender duct opening on the female side. The penial anatomy is quite characteristic, particularly the sheath (Figs. 5, 6, 7, 8) which encloses the middle part of the organ and the short flagellum. What at first appeared to be a highly characteristic stimulator is discussed later.

ATTEMPTS AT NAMING

Since neither A nor B agreed with any species described from the Islands either one or both could be endemic species previously undetected or, more likely, be introduced from elsewhere. Searching through the *Kaliella* (*sensu lato*) in the collections of the British Museum (Nat. Hist.) I found material of a Japanese species identified as *K. subcrenulata* Pilsbry (1901), now placed in the genus *Trochochlamys* Habe (1946) (established for *K. crenulata* Gude) which appeared virtually indistinguishable from B. Attempts to obtain fresh or preserved material from Japan met with no success but the anatomy of *T. crenulata* has been figured by Azuma (1982). The presence of a well-marked penial appendage, definitely lacking in species B, would appear to rule out this identity. Presumably *T. subcrenulata* has a similar anatomy to *T. crenulata* but appears not to have been figured and nothing can be accepted as certain without dissection.

Material of both A and B was sent to the late Alan Solem who pronounced A to be *Liardetia* (*Belopygmaeus*) *doliolum* (Pfeiffer, 1846) (with some slight doubt) and B *Liardetia* (*L.*) *samoensis* (Mousson, 1865). I could find no material of *doliolum* in the British Museum but material labelled *samoensis* was certainly so close to B as to suggest this was correct. H. B. Baker (1938–1941) dealt exhaustively with both of these species in his monumental work on the zonitid snails from the Pacific Islands. His descriptions indicate that profound differences in anatomy exist between the Seychelles species and those mentioned above. Moreover, Baker figures (Pl. 14, Fig. 9) *L. doliolum* as having a shell with an angulate body whorl whereas that of A is distinctly rounded. I have been unable to borrow any of Baker's original dissections and only meagre spirit material is available of the two Pacific species which may well be needed for more important studies at some future date by a much more competent anatomist. Shells of the two were, however, borrowed and careful comparisons made with the Seychelles material. Study of the shells of *L. doliolum* from the Bishop Museum (BPBM 82705, Guam, Agana) proves conclusively that it is not conspecific with A; they have fine spiral striae above (as well shown also by Solem, 1988, figs. 181, 182) and are

VERDCOURT: THE IDENTITY OF TWO EUCONULOID SNAILS

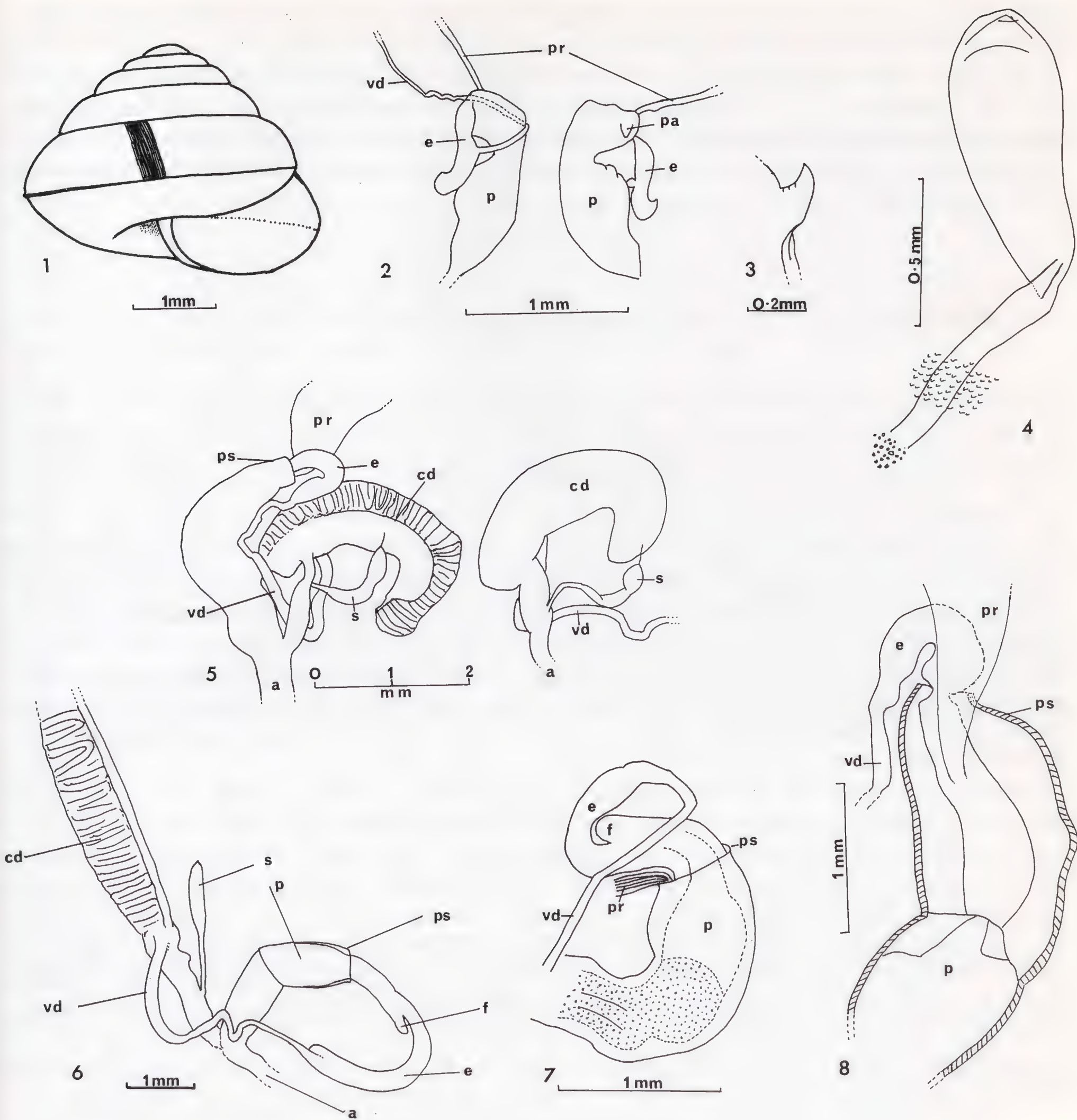


Fig. 1. *Lousia barclayi* (Benson) (Species 'B').
 Fig. 2. *Liardetia sculpta* (Möllendorff). a,b. penis.
 Fig. 3. *Liardetia sculpta* (Möllendorff). Dart.
 Fig. 4. *Lousia barclayi* (Benson) Spermatophore (from penis).
 Fig. 5. *Lousia barclayi* (Benson) Genitalia and same specimen in part twisted to show insertion of spermathecal duct.
 Fig. 6. *Lousia barclayi* (Benson) Genitalia of another specimen.
 Fig. 7. *Lousia barclayi* (Benson) Genitalia from a third less relaxed specimen.
 Fig. 8. *Lousia barclayi* (Benson) Penial complex with sheath cut open.

Explanation of anatomical symbols			
a	atrium	pa	penial appendage
cd	common duct	pr	penial retractor
e	epiphallus	ps	penial sheath
f	flagellum	s	spermatheca
p	penis	vd	vas deferens

definitely keeled; moreover, they are larger with much finer transverse striae. Shells of *L. samoensis* (BPBM 84412, Samoa, Tutuila) are certainly very similar indeed to B but B has a sharper keel with beading (thread-carinate) not just an angled shell; the basal sculpture is virtually identical. It is difficult to believe they are not conspecific but the anatomy absolutely precludes this since the spermatheca is not on the male side. This certainly makes one somewhat suspicious of the many identifications made of introduced small snails without anatomical studies.

FINAL IDENTIFICATION OF A

A careful study and comparison was then made of all the Pacific species described by Baker and similarities between *Liardetia sculpta* (Möllendorff) and A in both shell and anatomy became apparent. Further material was borrowed from the Bishop Museum (BPBM 153921, Caroline Islands, Ponape) and this conclusively proved that A is indeed *L. sculpta*. As a final check paratypes were borrowed from the Senckenberg Museum, Frankfurt (SMF 42767b/5, China, Macao) which left absolutely no doubt. The Seychelles material disagrees in some anatomical particulars with Baker's figure (Pl. 2, Figs. 19, 20) notably in having a shorter more globose spermatheca and a much less developed penial appendage but only dissection of a range of material from throughout the range would show the significance of this. The species is also known from Guam in the Marianas Islands but some further information shows that the species has been in the western part of the Indian ocean for a long while. Justin Gerlach informs me that recently Owen Griffiths from Mauritius visited the Seychelles and discovered species A. He was convinced that it is the same species as a common Mauritian one, *Lousia insularis* Godwin-Austen, 1908. Godwin Austen's original description and figure suggested this was correct but were inadequate for certainty; also he had not been able to make out the genitalia apart from the fact that the species was ovoviviparous. I therefore borrowed from the British Museum the types of three species described by Godwin-Austen from Mauritius: *Lousia insularis*, *L. duponti* and *Kaliella fourneauxensis*; *insularis* is without doubt species A. The other two are not close to either A or B. With characteristic perspicacity Godwin-Austen compared *L. insularis* with *Philonesia* Sykes which is related to *Liardetia*, both being in the Microcystinae.

SUGGESTED IDENTITY OF B

Having been alerted to the genus *Lousia* I decided that the type of the genus should be examined. Dr. R. C. Preece kindly loaned me all the material of *Helix barclayi* Benson from the Benson collection in the University Museum of Zoology, Cambridge. This comprises several lots including the shell selected by Godwin-Austen for figuring (1908, Pl. 10, Figs. 1-1b) which it seems reasonable to select as the lectotype. As Godwin-Austen pointed out none of the shells is as large as Benson records (i.e. 4 mm.). There is no doubt that *Lousia barclayi* (Benson) is by far the best match for species B encountered during this investigation but so far no description of the anatomy has been traced nor have I had the opportunity of examining preserved material from Mauritius. Knowing that E. H. Madge was well advanced with a revision of the Ereptinae at the time of his death, I searched his papers preserved in the Mollusca Library at the British Museum but failed to find any notes or drawings of the anatomy of *L. barclayi*; he clearly and rightly excluded it from the subfamily.

VERDCOURT: THE IDENTITY OF TWO EUCONULOID SNAILS

As Kennard (1943: 124) points out Germain's genus *Pseudocaldwellia* (Germain, 1918: 518, 1921: 134) is an absolute synonym of *Louisia*. Madge (1946: 229) records *L. barclayi* from Diego Garcia and also points out that the species is local in Mauritius whereas *L. insularis* i.e. *Liardetia sculpta* occurs in thousands in all low-lying districts.

The anatomy of species B has already been briefly described. Within the penis of one specimen is what at first sight was taken to be a massive stimulating organ (Fig. 4) but I suspected it might be a spermatophore. Baker mentions and figures (p. 90, Pl. 7, Fig. 9) one found in the penial prepuce of *Lamprocystis misella* (Fér.). The anatomy of B has been confirmed from a further lot of well preserved material collected at Casse Dent on 10 Jan. 1990 and the absence of the above mentioned structure from dissections of the new material confirms it is not a permanent feature. It would appear to belong to the Euconulinae and agrees in not being ovoviviparous (*Guppya* being the exception).

ACKNOWLEDGEMENTS

I am very grateful to Dr. R. H. Cowie, Associate Malacologist at the Bishop Museum, Honolulu for loaning me material of several species of *Liardetia*, to Dr. R. Jansen, Forschungsinstitut Senckenberg, Frankfurt-am-Main for the loan of type material of *L. sculpta*, to Dr. R. C. Preece of the University Museum of Zoology, Cambridge for the loan of original material of *Helix barclayi* Benson and to Dr. Peter Mordan of the British Museum (Nat. Hist.) for the loan of material named by Lt. Col. Godwin-Austen and permission to use the collections generally.

REFERENCES

- AZUMA, M., 1982. *Colored illustrations of the land snails of Japan*, pp. 333, pl. 64. Osaka.
- BAKER, H. B., 1938–1941. Zonitid snails from Pacific Islands, Part 1 *Bernice P. Bishop Museum Bull.*, **158** (1938), Part 2 *idem.* **165** (1940) Parts 3 & 4 *idem.* **166** (1941).
- BENSON, W. A., 1850. Characters of new species of *Helix* from India, Mauritius and the Cape of Good Hope; also a new Mauritian *Tornatellina* with remarks on the habits of a Cape *Succinea*. *Ann. Mag. nat. Hist.*, **6**: 251–256.
- GERMAIN, L., 1918. Contributions à la faune malacologique de Madagascar VI. Sur la classification de quelques Gastéropodes Pulmonés des îles de Madagascar et Mascareignes et description d'espèces nouvelles de cet archipel. *Bull. Mus. Hist. nat., Paris*, **24**: 516–524.
- , 1921. *Faune malacologique terrestre et fluviatile des Iles Mascareignes*. pp. 486, pl. 13, Angers.
- GODWIN-AUSTEN, H. H., 1908. On the animals of genera and species of Mascarene land shells belonging to the family Zonitidae collected by Mons. E. Dupont. *Ann. Mag. nat. Hist.*, **8**: 428–436, Pls. 9–11.
- HABE, T., 1946. Nihonsan bekkomaimaika no saikento. *Venus*, **14**: 200–217.
- KENNARD, A. S., 1943. Notes on the nomenclature of the Mascarene non-marine Mollusca. *Mauritius Inst. Bull.*, **2**: 115–136.
- MADGE, E. H., 1946. New records and species of land Mollusca from the Mascarene and Chagos Archipelagoes. *Mauritius Inst. Bull.*, **11**: 211–240.
- , 1949. The conchological manuscripts of the late E. Dupont (Jr.) *Mauritius Inst. Bull.*, **3**: 83–125.
- MARTENS, E. VON & WIEGMANN, F., 1898. Land und Süßwasser-Mollusken der Seychellen nach den Sammlungen von Dr. Aug. Brauer. *Mitt. zool. Samml. Mus. Naturk. Berl.*, 1898–1900 Heft 1, pp. 94.
- NEVILL, G. & H., 1871. Descriptions of new Mollusca from the eastern regions. *J. asiat. Soc. Beng.*, **40**: 1–11, pl. 1.
- PILSBRY, H. A., 1901. New Japanese marine, land and fresh-water Mollusca (part 2). *Proc. Acad. Nat. Sci. Philadelphia*, **53**: 401–408, pl. 19–21.
- SOLEM, A., 1988. Non-Camaenid land snails of the Kimberley and Northern Territory, Australia. 1. Systematics, affinities and ranges. *Invertebr. Taxon.*, **2**: 455–604, 217 figs.
- VERDCOURT, B., 1986. Some records from Kenya, Seychelles and Dependencies. *Conchol. Newsl.* No. **96**: 311–333.

NOTE

Since the above was written, Owen Griffiths of Mauritius has sent me extensive dry material of *Lousia insularis* (= *Liardetia sculpta*) and *Lousia barclayi* from several localities in the Mascarenes, also spirit material of *L. barclayi*, all confirming my previous conclusions. In addition dry and spirit material of a third species *L. duponti* Godwin-Austen suggests that this may be either *Liardetia samoensis* (Mousson) or *L. doliolum* (Pfr.). Unfortunately loan material of these had been returned by the time that Griffith's material had arrived — extreme similarity to *L. doliolum* in both shell and anatomy is upset by one character; H. B. Baker states that it has a long caudal tail and *duponti* definitely does not. Until I have examined Pacific material all I am prepared to state is my conviction that *Lousia duponti* is a *Liardetia* introduced from the Pacific.

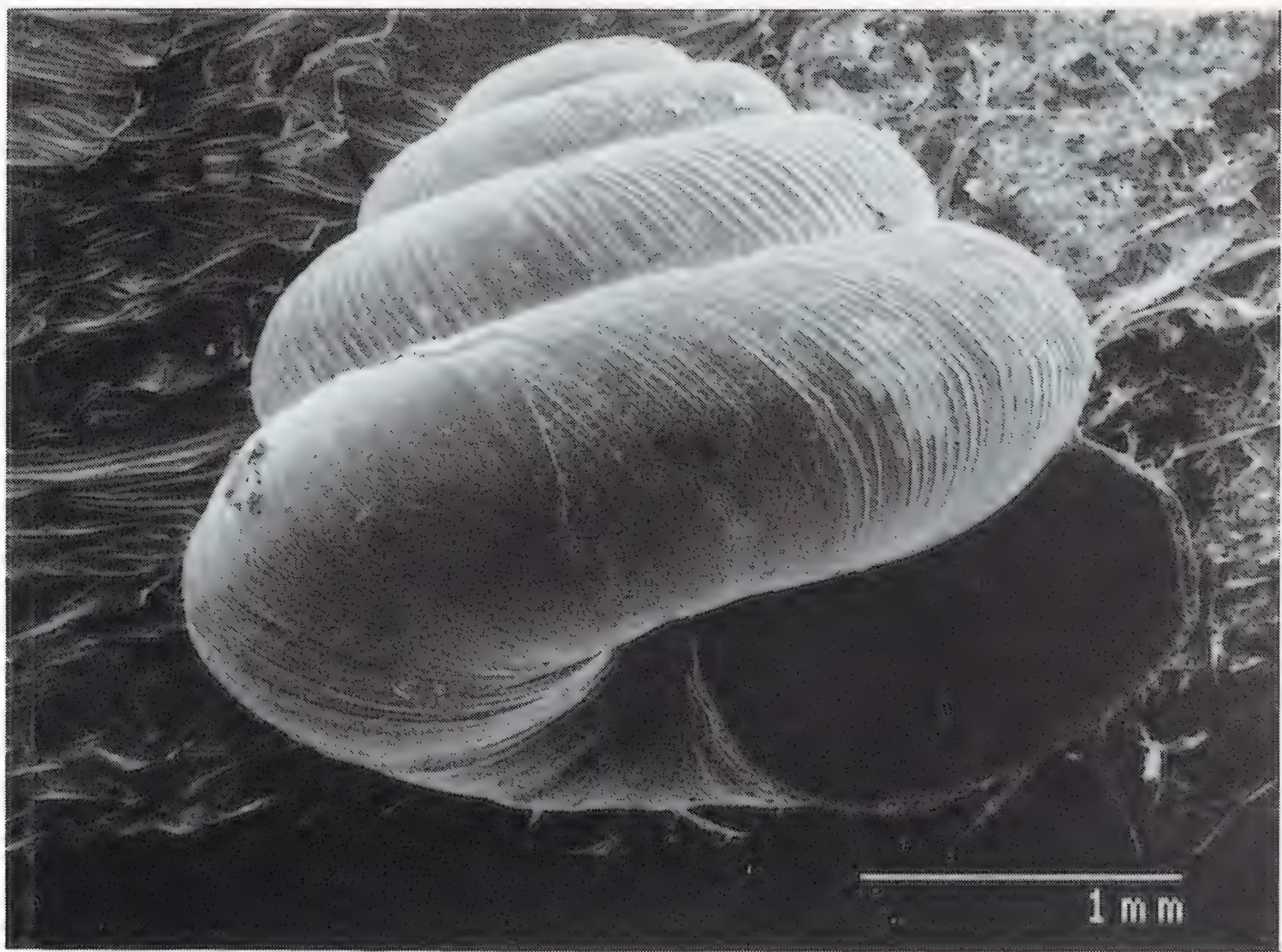


PLATE 10

A. *Liardetia sculpta* (Möllendorff) (species 'A'). S.E.M. of shell. Seychelles, Mahé, Le Niol.
B. *Louisia barclayi* (Benson) (species 'B'). Seychelles, Mahé, Casse Dent.

THE NON-MARINE MOLLUSCA OF ULVA, INNER HEBRIDES

C. R. C. PAUL¹

(Accepted for publication, 14th December, 1991)

Abstract: Over 40 species of non-marine molluscs are recorded from the island of Ulva, together with information on their occurrence and habitats.

In April 1991 I had the opportunity to visit Ulva (Fig. 1), a small Hebridean island off the west coast of Mull, primarily to examine archaeological excavations in a cave on the island (Bonsall *et al.* 1987, 1989) from which I had previously seen samples containing non-marine molluscs. Although brief, my visit allowed me some time to collect and record living molluscs for the Society's census scheme and as an aid to interpreting the environmental conditions when the archaeological deposits were accumulating. Despite being only 8 by 6 km, Ulva includes parts of four 10 km squares. During my visit I managed to collect in three of them, but there was insufficient time to visit NW Ulva and the neighbouring island of Gometra. Ulva is entirely composed of Tertiary basalts, and a rather unpromising environment for non-marine molluscs. Unlike Colonsay and Oronsay, the non-marine molluscs of which I recorded in 1975 (Paul 1976), Ulva has no sandy beaches and no machair formed by calcareous shell sand being blown inland during storms. As a result all habitats are rather acid, some extremely so, and a considerably less rich fauna was expected. Nevertheless, I did manage to discover over 40 species during my three day visit. The purpose of this note is to record the molluscs and the habitats in which they were found. As far as I am aware, there has been only one previous report of non-marine molluscs from Ulva (Annandale 1922), and a small collection exists in the Royal Scottish Museum, Edinburgh from Annandale's visit in 1921. Species previously recorded are indicated by an asterisk in the faunal list. Annandale found three additional species that I did not see, *Hydrobia ulvae* (Pennant), a brackish-water species, the freshwater limpet *Ancylus fluviatilis* Müller and *Zonitoides nitidus* (Müller). Nomenclature follows Waldén (1976) and Kerney (1976).

COLLECTING LOCALITIES

1. Cille Mhic Eogbainn. a) strandline, b) coastal cliffs with stunted hazel bushes and a rich ground flora including bluebells, c) marshy ground with flags, d) walls of ruined farmhouse, e) under ivy on inland cliffs by path.
2. East of Ormaig. a) wooded stream valley, b) abandoned crofts, c) wooded cliffs.
3. Ulva Cave. a) scree and rock walls at entrance to cave, b) well wooded cliffs to east and west of cave, c) marshy ground at foot of scree west of cave, d) springs at foot of cliff immediately adjacent to cave both east and west, e) strandline south of cave, f) stream by shore, g) under ivy on cliff east of cave.
4. Ulva Church. a) churchyard, b) wooded slopes north of church.

¹ Department of Earth Sciences, Liverpool University, L69 3BX.

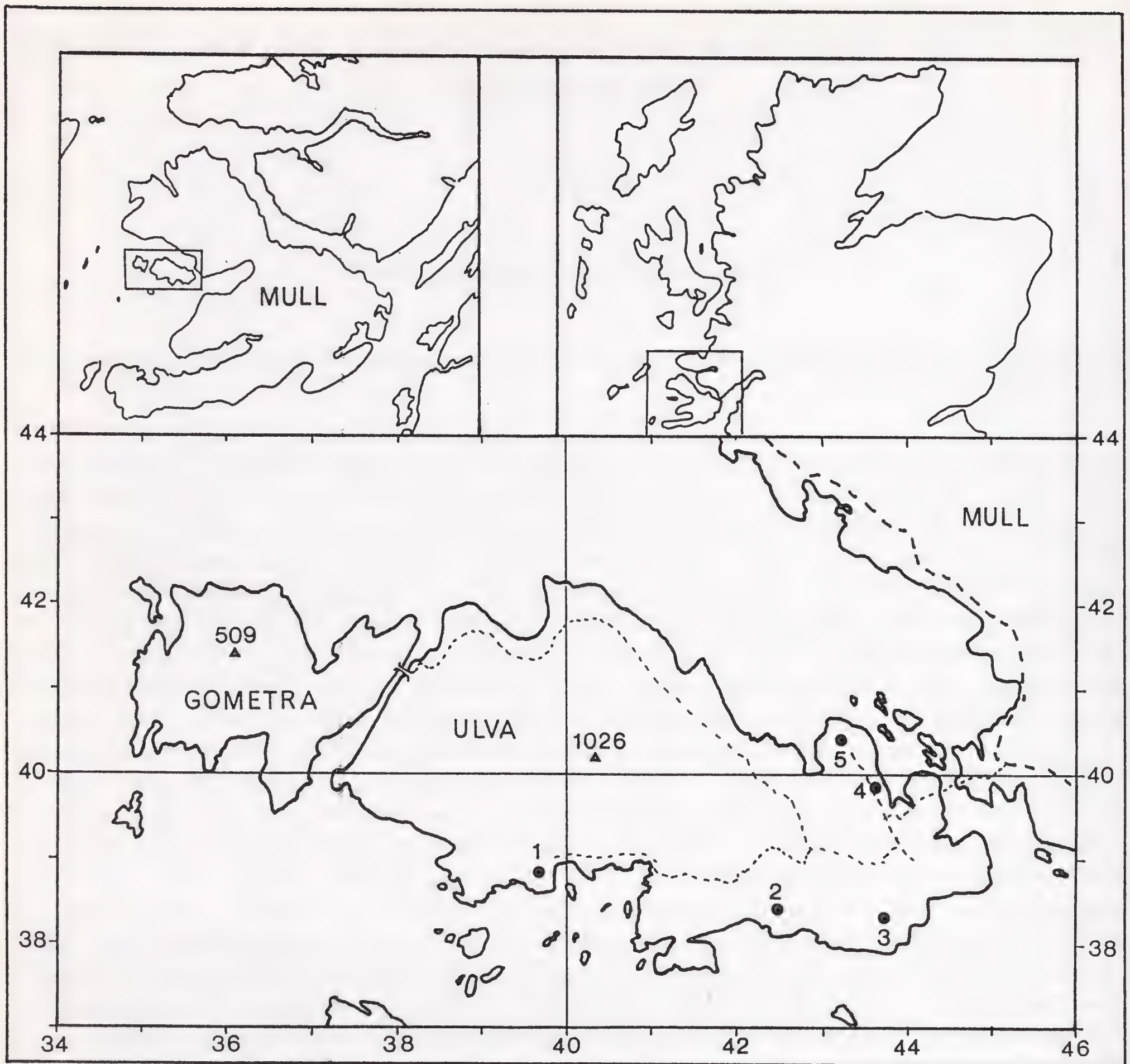


Fig. 1. Collecting sites on Ulva.

5. Ardalum House. a) Wooded slopes with ash trees west of house, b) strandline NW of house, c) wet ground north of house, d) well wooded coastal cliffs NW of house.

DISCUSSION

To date two samples from the archaeological excavation have been examined for non-marine molluscs (Paul in press). The first consisted of a small number of shells hand picked on site and the second was a single bulk sample of 1.75 kg of sediment taken from the base of an Obanian (Mesolithic) shell midden near the cave entrance. The latter included one additional species, *Vertigo pusilla* Müller. This species seems to have suffered considerable reduction in numbers and distribution since the Mesolithic and may well be locally extinct on Ulva.

With such limited sampling it is perhaps premature to comment on the distribution of

PAUL: THE NON-MARINE MOLLUSCA OF ULVA, INNER HEBRIDES

TABLE 1

	Shore				Wooded cliffs					Ivy			Wet					Human			
Species	1a	3e	5b	1b	2a	2c	3b	4b	5a	5d	1e	3g	1c	3c	3d	3f	5c	1d	2b	3a	4a
<i>Lymnaea truncatula</i> *														L	L	L					
<i>L. peregra</i> *														L		L					
<i>Pisidium casertanum</i> *														L	L						
<i>P. personatum</i> *															L						
<i>Carychium minimum</i>	L								L	L											
<i>C. tridentatum</i>					L	L	L		L											L	
<i>Cochlicopa lubrica</i> *				L	L	L	L		D									L		L	
<i>C. lubricella</i>																				D	
<i>Columella aspera</i>				L	L		L							L							
<i>Vertigo substriata</i>					L		L														
<i>V. pygmaea</i>																				D	
<i>Leiostyla anglica</i>					L	L	L			L											
<i>Lauria cylindracea</i> *					L		L				L	L						L	L	L	
<i>Acanthinula aculeata</i>					L	L	L			L		L									
<i>Spermodea lamellata</i> *							L														
<i>Punctum pygmaeum</i>				L	L	L	L		L	L	L	D									
<i>Discus rotundatus</i> *	L	L		L	D		L				L									L	
<i>Arion ater</i> *	L		L				L	L	L									L	L	L	
<i>A. subfuscus</i>																				L	
<i>A. circumscriptus</i>								L	L												L
<i>A. silvaticus</i>									L									L			
<i>A. hortensis</i> agg.*									L												
<i>A. intermedius</i>							L	L	L									L		L	
<i>Vitrina pellucida</i> *							D													L	
<i>Vitrea crystallina</i> *						L				L	L	L									
<i>V. contracta</i>				L			L											L		D	
<i>Nesovitrea hammonis</i> *							L														
<i>Aegopinella pura</i>	L			L	L	L	L	L	L	L	L	L								D	
<i>A. nitidula</i>					L																
<i>Oxychilus cellarius</i> *				L	L		L											L		L	
<i>O. alliarius</i> *	L	L		L		D	L		L		L	L						L	L	D	D
<i>Zonitoides excavatus</i> *							L														
<i>Limax marginatus</i>							L	L	L											L	
<i>Deroceras laeve</i>														L			L				
<i>D. reticulatum</i>		L	L						L									L	L	L	
<i>Euconulus fulvus</i>				L	L		L					L									
<i>Clausilia bidentata</i> *	L	L			L	L					L							L			
<i>Balea perversa</i> *				D	L	D	L			L		D									
<i>Zenobiella subrufescens</i> *					L																
<i>Cepaea nemoralis</i> *																		D		L	
<i>C. hortensis</i>																				L	

L = live collected, D = dead shells only

species. However, one or two observations may be pertinent. Field observations indicated that *Lauria cylindracea* (da Costa) was associated exclusively with human sites, but analysis of sievings and litter samples demonstrated its presence in small numbers in natural habitats. Distributions of some other species seemed to be very local, suggesting the possibility of human interference or introduction. Apart from a single specimen in the wood west of Ardalum House, the slug *Arion silvaticus* Lohmander was only seen near the ruined farmhouse at locality 1d, where it was very common. *Arion subfuscus* (Draparnaud) was only seen near the scree at the mouth of Ulva Cave. *Vitrina pellucida* (Müller) was common there and seen dead at only one other site. *Deroceras reticulatum* (Müller) occurred either under driftwood on strandlines or around human habitations, while *Cepaea* thrives in the scree at

Ulva Cave and fragments of shell were found by the farmhouse at locality 1d. *Cepaea* is present in the midden sample. It would be very interesting to know if its present occurrence at the cave dates from human introduction several thousand years ago.

ACKNOWLEDGEMENTS

I am grateful to Clive Bonsall for the opportunity to visit Ulva and to examine the samples from the midden at Ulva Cave. Michael Kerney (Natural History Museum, London) and David Heppell (Royal Scottish Museum, Edinburgh) provided information on, and a copy of, Annandale's list, respectively.

REFERENCES

- ANNANDALE, T., 1922. The land and freshwater molluscs of some islands of the Inner Hebrides. *Scot. Nat.* (1922): 19–27.
- BONSALL, C., SUTHERLAND, D. G. & LAWSON, T. J., 1987. *Ulva Cave: excavation. Report No. 1.* Edinburgh, University Departments of Archaeology, 10 pp.
- BONSALL, C., SUTHERLAND, D. G., LAWSON, T. J., RUSSELL, N. J. & BARNETSON, L., 1989. *Ulva Cave: excavation. Report No. 2.* Edinburgh, University Department of Archaeology, 9 pp.
- KERNEY, M. P., 1976. A list of the fresh and brackish-water Mollusca of the British Isles. *J. Conch., Lond.* **29**: 26–28.
- PAUL, C. R. C., 1976. The non-marine Mollusca of Colonsay and Oronsay, *J. Conch., Lond.* **29**: 107–110.
- , in press. Non-marine molluscs. In Bonsall, C. *et al.* *Ulva Cave: excavation. Report No 3.* Edinburgh, University Department of Archaeology.
- WALDÉN, H. W., 1976. A nomenclatural list of the land Mollusca of the British Isles. *J. Conch., Lond.* **29**: 21–25.

THE REDISCOVERY AND ANATOMY OF *TROCHONANINA GWENDOLINAE* (PRESTON) (PULMONATA : UROCYCLIDAE)

B. VERDCOURT¹

(Accepted for publication, 15th November, 1991)

Abstract: Material collected in eastern Tanzania shows that *Ledoulxia pseudojenynsi* Thiele is conspecific with the earlier described *L. gwendolinae* Preston. Anatomical investigation shows the species is a typical *Trochonanina*.

About 30 years ago when dealing with the anatomy of *Sitala jenynsi* (Pfeiffer), I mentioned (1963: 190) the need for material of *Ledoulxia pseudojenynsi* Thiele and *L. gwendolinae* Preston, both of which resembled the *Sitala* rather closely; in fact I suggested Thiele's species might prove to be synonymous with Preston's. I was, therefore, pleased when Peter Kasigwa (Dar es Salaam University) showed me some *Trochonanina* he had been unable to identify and I recognised them to be a perfect match of Thiele's adequate description and figure. The material was collected by Kasigwa in Tanzania, Bagamoyo District, Miono Forest, Mwafuma; it had been drowned outstretched and preserved in spirit which greatly facilitated the anatomical investigation. Thiele (1931: 395, Fig. 5) described *Ledoulxia pseudojenynsi* from material collected in Tanzania by Stuhlmann² (in SE. Uluguru Mountains), Vosseler (Tanga District, Pongwe and perhaps Amani) and Conradt. *L. gwendolinae* was described by Preston with merely the locality 'Usagara' and no collector mentioned. The holotype is preserved at Tervuren but I found authentic material, probably paratypes, in the British Museum (Nat. Hist.). These specimens were BM 84.2.19.30 labelled Usagara, part of a lot purchased from the ill-fated Rev. James Hannington³ (later murdered in East Africa) and BM 85.5.25.1–3 part of a lot from Mr. J. Last³ collected 'on the plains within 50 miles of Mamboya'. Although material from both these collectors has at times been thought to exist only in the British Museum it is clear that duplicates also reached others. The collectors probably kept some material back for others before presenting it, although Preston's frequent failure to give the collector's names could hint at a more illegal source. Clearly the holotype of *L. gwendolinae* was almost certainly collected by Hannington. Comparison of Kasigwa's specimens with the BM material indicates that *gwendolinae* differs only in size from *pseudojenynsi* being slightly larger. I am quite certain they were from different populations of the same species. The synonymy is therefore as follows:—

***Trochonanina gwendolinae* (Preston)**

1910 *Ledoulxia gwendolinae* Preston, p. 527, Pl. 7, Fig. 9

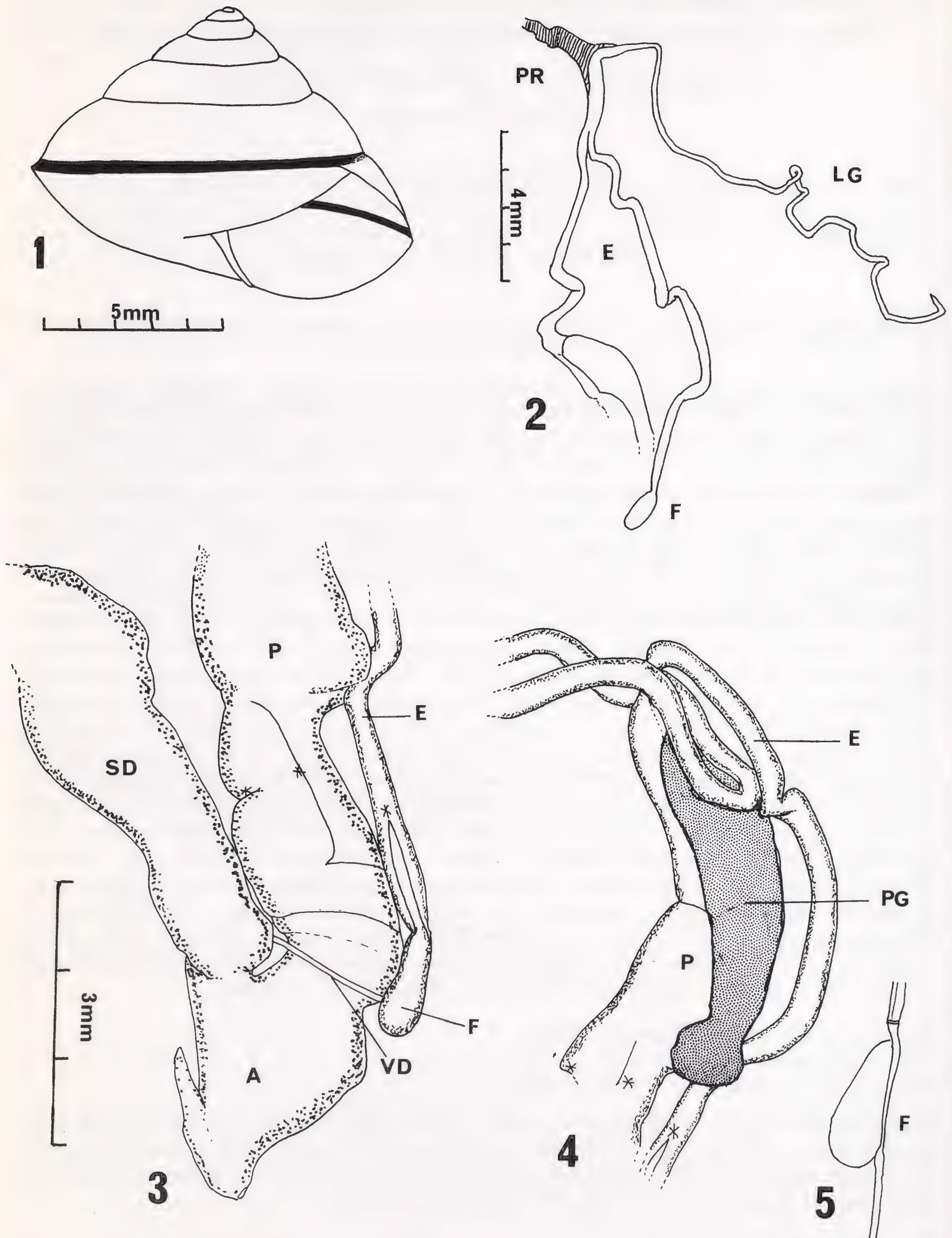
1931 *Ledoulxia pseudojenynsi* Thiele, p. 395, Fig. 5

Description: Shell similar to that of *Sitala jenynsi* (Pfeiffer) but thinner; apical whorls obscurely spirally striate and the rest with feeble transverse element, not at all crisply striate and scarcely perceptible under an ordinary lens, crossed by very fine spiral striae visible only at high magnifications; base with fine close wavy spiral striae.

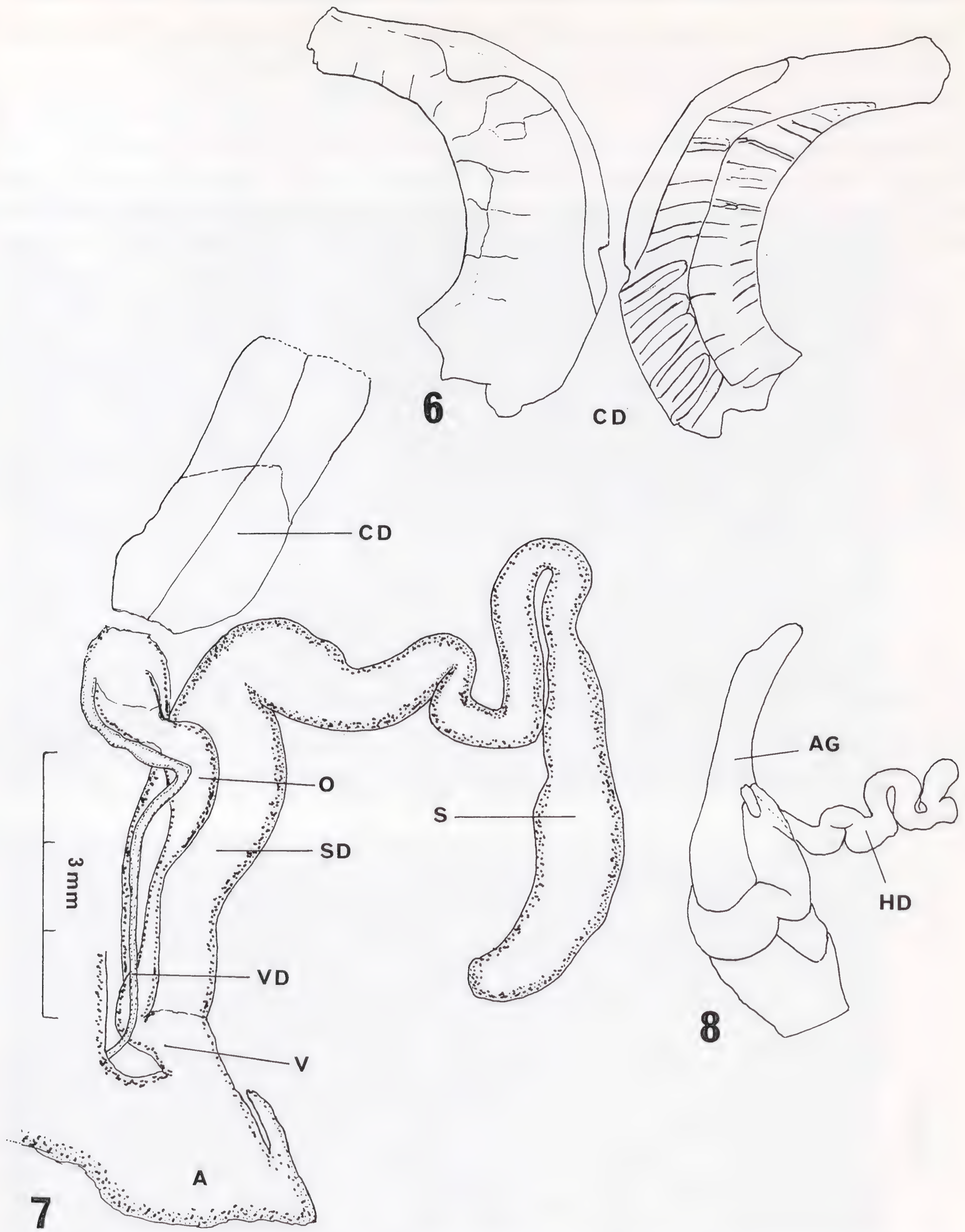
¹ Spring Cottage, Kimbers Lane, Maidenhead, Berks., SL6 2QP.

² This was omitted from my list given in the *Conchol. Newsl.* **109**: 181 (1989).

³ See *Conchol. Newsl.* **77**: 248–249 (1981) & **74**: 248–249 (1980).



Figs. 1–5. *Trochonanina gwendolinae* (Preston). 1 – shell. 2 – upper part of male genitalia. 3 – lower part of genitalia. 4 – middle part of male genitalia showing penial gland. 5 – flagellum.



Figs. 6–8. *Trochonanina gwendolinae* (Preston). 6 – part of common duct. 7 – part of genitalia showing spermatheca. 8 – albumen gland and hermaphrodite duct.

Abbreviations used in the figures

A – atrium
AG – albumen gland
CD – common duct
E – epiphallus
F – flagellum
HD – hermaphrodite duct
LG – lime gland

VD – vas deferens

O – oviduct
P – penis
PG – penial gland
PR – penial retractor
S – spermatheca
SD – spermathecal duct
V – vagina

Mantle with a very pale grey-brown mid-longitudinal band of markings. Caudal tail well developed, 3 mm. long, tapering to a fine point; shell-lobes virtually absent.

Thiele examined the radula and briefly described it as follows "according to its radula it belongs to *Ledoulxia*, the middle tooth and six lateral teeth have long acute cusps and the three innermost marginals have the outer cusp moved backwards and the further teeth [marginals] have two evident cusps." My own examination of the radula agrees well, there being 6–7 true laterals, $\pm/3$ transitional marginals and about 90 marginals. Scanning electron micrographs have been taken of part of the radula (Pl. 11). The genital anatomy is shown in Figs. 1–8 and closely resembles that of *Trochonanina mozambicensis* (Pfeiffer) the type species of the genus (see Watson in Connolly 1925, pl. 8, Fig. 3, Verdcourt 1960: 246, 1961, Figs. 5, 12) having a similar free glandular appendage. The lime-gland is long and convoluted with the penial retractor attached to its proximal end rather than to the epiphallus before its junction with the lime-gland; flagellum narrowly elongate ovoid, white and chalky.

Although it is possible to identify *Trochonanina* from their overall shapes and details of transverse and spiral sculpture, many species attributed to this genus may not actually belong to it since they have never been examined anatomically. No proper revision of the genus can be attempted until all the species have been dissected.

REFERENCES

- CONNOLLY, M., 1925. The non-marine Mollusca of Portuguese East Africa. *Trans. R. Soc. S. Afr.*, **12**: 105–220, Pls. 4–8.
- PRESTON, H., 1910. Additions to the non-marine molluscan fauna of British and German East Africa and Lake Albert Edward. *Ann. Mag. nat. Hist. Ser. 8*, **6**: 526–536, pls. 7–9.
- THIELE, J., 1931. Ueber einige hauptsächlich afrikanischen Landschnecken. *Sber. Ges. naturf. Freunde Berl.*, 1931: 392–403, 21 figs.
- VERDCOURT, B., 1960. Some further records of Mollusca from N. Kenya, Ethiopia, Somaliland and Arabia, mostly from arid areas. *Rev. Zool. Bot. afric.*, **61**: 221–265.
- , 1961. A new species of Helicarionidae from Portuguese East Africa together with a discussion of the affinities of several other East African species. *J. Conchyl. Paris.*, **101**: 120–134, Figs. 1–18.
- , 1963. A note on *Sitala jenynsi* Pfeiffer (Helicarionidae). *J. Conch., Lond.* **25**: 188–192.

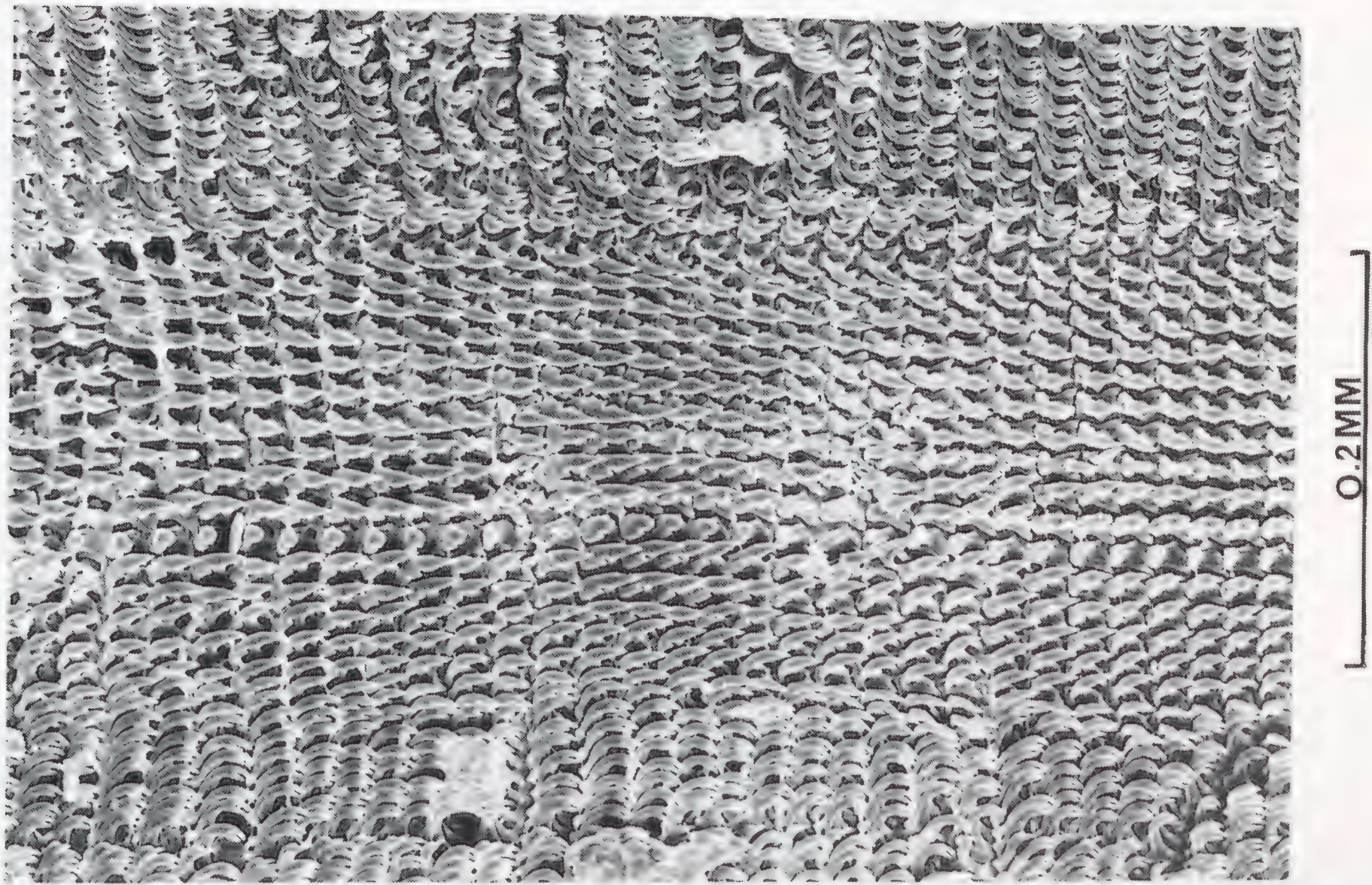
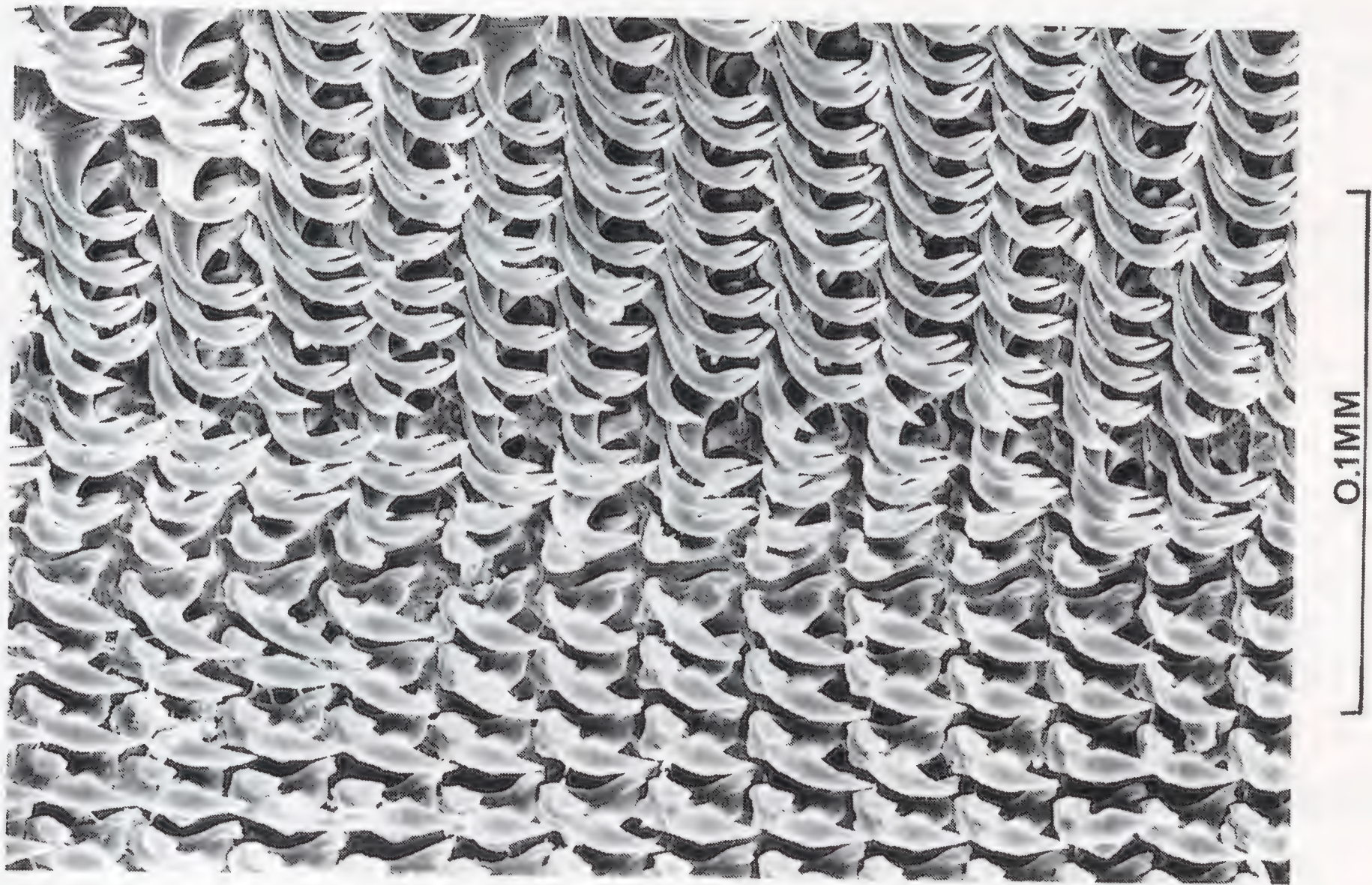


PLATE 11

Trochonanina gwendolinae (Preston). Tanzania, leg. P. Kasigwa. Part of radula.

COMMUNICATIONS

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Applications published in the Bulletin of Zoological Nomenclature The following applications were published on 30 September 1991 in Vol. 48, Part 3 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these applications is invited for publication in the *Bulletin* and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD.

Case 2710

CLAVIDAE McCrady, 1859 (Cnidaria, Hydrozoa) and CLAVINAE Casey, 1904 (Mollusca, Gastropoda): proposal to remove the homonymy

Walter O. Cernohorsky

6 Rapallo Place, Farm Cove, Pakuranga, Auckland 6, New Zealand

Paul F. S. Cornelius

Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

Alexander V. Sysoev

Laboratory of Helminthology, Academy of Sciences of the U.S.S.R., Lenin Avenue 33, 117071 Moscow-71, U.S.S.R.

Abstract. The purpose of this application is to remove the homonymy between the family-group names CLAVIDAE McCrady, 1859 (Cnidaria) and CLAVINAE Casey, 1904 (Mollusca). Both names are in use. It is proposed that the molluscan name, which is used for a subfamily, be altered to CLAVUSINAE by changing the stem of the type genus *Clavus* from Clav- to Clavus-.

Case 2766

***Conus fulmen* Reeve, 1843 (Mollusca, Gastropoda): proposed conservation, and *Conus berghausi* Michelotti, 1847: proposed precedence over *C. demissus* Philippi, 1836**

A. J. Kohn

Department of Zoology, University of Washington, Seattle, Washington 98195, U.S.A.

Abstract. The purpose of this application is the conservation of the specific name of *Conus fulmen* Reeve, 1843 by the suppression of its unused senior subjective synonym *C. modestus* Sowerby, [1833], and the conservation of *C. berghausi* Michelotti, 1847 by giving the name precedence over *C. demissus* Philippi, 1836. The species are marine prosobranch gastropods.

The following opinions were published on 30 September 1991 in Vol. 48, Part 3 of the *Bulletin of Zoological Nomenclature*.

Opinion 1650. CYMATIINAE Iredale, 1913 (1854) (Mollusca Gastropoda) and CYMATIINAE Walton in Hutchinson. 1940 (Insecta, Heteroptera): homonymy removed.

Opinion 1651. *Mytilus anatinus* Linnaeus, 1758 (currently *Anodonta anatina*; Mollusca, Bivalvia): neotype designation confirmed.

FURTHER NOTES ON ANOSTOMA (GASTROPODA: BULIMULIDAE)

Since my previous communications on this genus (Verdcourt, B. *Conchol Newsl.* **115** (1990) pp. 326–329, *J. Conch., Lond.* **34** (1992) pp. 81–2) further material has come to hand including members of the group with the angular and sutural lamellae separated by a narrow fissure, of which no material was present in the British Museum (Nat. Hist.) nor at Cardiff. Apart from this Fred Woodward has loaned me five specimens from the collection preserved at Glasgow and four from R. P. Scase's collection.

The most important material examined is two shells given to me by my colleague Dr. Nigel Taylor found whilst collecting Cactaceae in Brazil since, not only is it of a species not represented in the national collection but also has exact data as follows. Brazil, Bahia: Mun. Campo Formoso, 19 km. SW. of Maçaroca on dirt road, Fazenda de Lagoa d Anjico 9° 57'S, 40° 23'W, 700 m., limestone, 8 Jan. 1991, leg. N. P. Taylor, D. C. Zappi & U. Eggli. It is clearly of the group of *A. baileyi* of Solem and seemingly a good match for the figures in Solem's paper save that the

peristome reaches the top of the spire in *baileyi*. *A. baileyi*, however, was described from Salobra in the Matto Grosso; in the Pantanal Region, Salobra is a river crossing the railway to Corumba near the Brazilian, Bolivian and Paraguayan borders SE. of 20°S, 57°W., a very long way from the locality of the Taylor specimen, I therefore carefully studied Weber's paper (Weber, A. *Zool. Jahrb.* **50** (1925) pp. 273–282, t.5) on the material collected by Lützelburg where the first two species of this group were described, *A. rossi* and *A. luetzelburgi* (originally spelt *lützelburgi* which must be corrected according to the 1985 Code Art. 32 (d) (i) (2)). *A. luetzelburgi* was described from West Bahia, S. Disiderio State, in a cave and from Goyaz State, Serra Geral de Goyaz, cave 90 m. under the surface and it is with this species I identify the Taylor specimens, one of which has been presented to the British Museum and the other to the Senckenberg Museum, Frankfurt-am-Main. Attempts to borrow the types which I had assumed were probably in the Zoological Museum at Munich proved unsuccessful.

The specimens from the Scase Collection clearly belong to two species and as usual were devoid of data. One is a very small specimen of *A. ringens* (L.) 19×10.5 mm with a dark peripheral band and a very narrow one just below the suture and another a slightly larger specimen of the same species. Two others, one labelled *A. octodentatum* ('f. *depressum* Lam. 1822 syn. *verreauxianum* Hupé 1857') similarly have no data whatsoever and measure 30×15 mm. and 31.5×14.5 mm. respectively the former being 'ex Norris Coll. lot 540'. These undoubtedly match *A. rossi* Weber and are deceptively similar to my *A. octodentatum brunneum* Verdcourt but of course have a different sinus. *A. rossi* was described from West Bahia, S. Disiderio State, Ca-Höhle (presumably Ca is the name of a cave) 70 m. below ground, also in a cave in the Serra Geral de Goyaz.

The specimens from the Glasgow Collections are of less interest and not one had a locality other than 'Brazil'. One labelled *A. verreauxi* Pfr., i.e. *verreauxianum* Hupé is I think *octodentatum* Fischer von Waldheim. Another labelled *A. depressum* Lam. figured by T. Gray in 1848 on plate 93, fig. 1 & 2 of his *Icones Conchyliorum terrestrium**; the accompanying text gives *Helix ringens* L. in synonymy but not in the sense Pilsbry and I accepted. This specimen also is probably *A. octodentatum* from which *depressum* (= *verreauxianum*) is probably not distinct. A third specimen is labelled *A. ringens* Desh. and has only four teeth in the aperture agreeing with *depressum*. The final pair of specimens labelled *A. globulosum* Lam. are merely variants of true *A. ringens* (L.). One was figured by T. Gray on plate 93, fig. 3, 4.

Woodward drew my attention to the fact that there is a genus in fishes *Anostomus* L. T. Gronovius (*Zooph.* 1; 122 (1763) clearly based on the same Greek roots. There is also an *Anastomus* Bonnaterre (*Encycl. Meth. (Orn.)* 1: xciii (1790) in birds. *Anostoma* Fischer von Waldheim dates from 1807. There are also two later *Anostomus* both in fishes. Although Art. 58 of the Code lays down many variant spellings deemed to be identical as far as species are concerned, in the case of genera Art. 56 b makes it clear that one letter differences are permissible.

Examining shells of this genus it is clear how the shells with an actual perforation in the outer lip have evolved from forms like *A. octodentatum* via the *A. baileyi* group having a deep fissure in the sinus between the angular and sutural lamellae; this change was accompanied by strong reduction in size. Some really detailed studies of the ecology of the species might throw light on this.

B. VERDCOURT

Spring Cottage, Kimbers Lane, Maidenhead, Berks., SL6 2QP

WHAT IS *MOARIA CHAPERIANA* BOURGUIGNAT?

Bourguignat (Bourguignat, J. R. *Mollusques de l'Afrique Equatoriale Tanganika*. Paris (1889)) described a small shell under the name *Moaria chaperiana* collected by Leroy in Usagara, Nguru Mountains. Von Martens (Martens, E. von. *Beschalte Weichthiere in Möbius, Deutsch Ost-Afrika*, **4**, (1897). Abt.1. Berlin.) later also attributed a specimen collected 'zwischen Mbassa (is this Mombassa or somewhere in the East Usambaras?) und Tanga' by Conradt to this species. It has never been satisfactorily established to what species this name actually refers. The following is a translation of Bourguignat's account with additions.

Dealing with the genus *Moaria* Chaper, a genus founded for *M. conica* Chaper, a West African species from the Guinea coast with trochid form and spiral furrows ornamenting the upper part of the whorls, Bourguignat also refers there *Helix talcosa* Gould and *Helix calabarica* Pfeiffer from Guinea and Gabon respectively. He continues 'the Rev. Father Leroy has discovered in the humid and wooded parts of Nguru to the north of Usagara a minuscule species of this genus' which he describes as *M. chaperiana*. The Latin description is quite extensive – shell minute, narrowly perforate, conic, fragile, pellucid, corneous, smooth beneath, above spirally substriate; spire shortly conic nevertheless somewhat obtuse at the summit; whorls 6, tectiform, scarcely subconvex, slowly increasing, separated by a slightly impressed suture; last whorl obscurely subangulate, at the insertion shortly subdescendent; aperture suboblique, somewhat lunate, irregularly transversely oblong; peristome straight acute, beneath slightly subpatulous and also slightly thickened; columella margin at top triangularly expanded; alt. and diam. equal 2 mm.; alt. of

* I think this has to be looked on as a published work.

COMMUNICATIONS

aperture 1 mm., breadth 1.25 mm. He continues in French 'This very small species to which I have attributed the name of the creator of the genus *M.* Maurice Chaper is distinguished from its congener from Assinie by its much smaller size at 2 mm. also from *conica* which measures 8 mm., by its spiral furrows less pronounced, by its last whorl less angular and by its aperture of a different form. The species of this genus have an aspect very particular which does not allow them to be confounded with either *Sitala* or with *Trochonanina*. A final observation seems to make no sense—Bourguignat indicated that it would have been easy to take the new species for an unknown shell (inconnu) but for certain aperture characters which were a certain sign of adult state. It would make sense if instead of unknown one substituted immature and I think he must have meant this.

With such a description it ought to be easy to identify the species with recent material but I have never been able to do so. The type has not been found in Paris or Geneva. The Conradt specimen mentioned by Von Martens was not found by me when I visited the Berlin Museum in the 1950's. The trochoid shape suggests *Kaliella* but *K. barrakporensis* (Pfeiffer) has a smooth apex and close, strong transverse striae, also a distinct keel on the body whorl and, moreover, is too big. *K. iredalei* Preston is a smaller shell with a rounded keel and exactly the right size but the sculpture is of excessively fine transverse striation. My original suggestion (Verdcourt, B. *Achatina* 11 (1983) pp. 200–239, *Conchol. Newsl* **98** (1986) pp. 369–377) of *Guppya rumrutiensis* (Preston) must be wrong because it is not trochoid but wider than high and has only four whorls but there are faint spiral striae (hardly 'sillons'). *Afroconulus* species are ruled out by having very pale whitish shells about twice the size but they are spirally striate above. Juveniles of *Trochonanina* and *Trochozonites* are also eliminated since ones as small as 2×2 mm. would never have six whorls. Thus it really seems impossible to equate Bourguignat's name with any modern material; it can only be a species which has never been recollected or the original description is very faulty. The attention of collectors is drawn to the need to collect minute species in the Nguru Mountains in what little forest may remain there.

B. VERDCOURT

Spring Cottage, Kimbers Lane, Maidenhead, Berks. SL6 2QP

TWO MASCARENE *TROPIDOPHORA* (POMATIASIDAE) FOUND IN TANZANIA

Whilst attempting to name some *Tropidophora* material from Madagascar and East Africa I found a packet labelled 'Bagamoyo, N. of Dar es Salaam, 1965, N. J. Morris, R. H. Bates and M. K. Howorth' (all present or former members of the Dept of Palaeontology of the British Museum (Nat. Hist.)). The two *Tropidophora* species it contained were clearly not native to East Africa; one proved to be *T. michaudi* (Grat.) = *T. barclayana* (Pfeiffer)), a Mauritian species, and the other *T. articulata* (Gray) a species from Rodrigues. There is of course some shipping between Dar es Salaam (and perhaps even Bagamoyo) and the Mascarenes but I do not believe the species can be truly naturalised. Bagamoyo is too well known a place for such large and strikingly ornamented shells to be overlooked. Unfortunately no details of the occurrence are recorded on the labels and the collectors can supply no further information. Casual introduction attached to some cargo or other is probably the explanation.

B. VERDCOURT

Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB

VERTIGO LILLJEBORGI WESTERLUND ON ANGLESEY

Vertigo lilljeborgi is a subarctic snail whose main centre of distribution in the British Isles lies in Scotland and northern England, with outliers in Ireland (Kevan, D. K. & Waterston, A. R., *J. Conch.*, *Lond.* **19**: (1933) pp 296–313). More recently scattered colonies have been found in north and mid Wales (Dance, S. P., *J. Conch.*, *Lond.* **27**: (1972): pp. 387–389. Chater, A. O., *J. Conch.*, *Lond.*, **32**: pp. 147–148.) Most of the known localities for this mollusc are along the shores of lakes and rivers, in marshes that are inundated during periods of high water (Kevan, D. K. & Waterston, A. R., *J. Conch.*, *Lond.* **19**: (1933) pp 296–313, Kerney, M. P., *J. Conch.*, *Lond.*, **28**: (1974) pp 225–231).

A single individual of this species was found on 6th October 1988 in a pitfall trap in moss on Cors Erddreiniog National Nature Reserve, Anglesey (SH479823). The sampling was conducted as part of the Nature Conservancy Council's Welsh Peatland Invertebrate Survey. The habitat was a spring fed flush with groundwater derived from underlying Carboniferous Limestone strata. The high loading of lime in the water was indicated by the deposition of tufa along the flush line. Vegetation was dominated by the rushes *Juncus subnodulosus* and *J. articulatus* with Purple Moor Grass *Molinia caerulea* and a number of sedge *Carex* species. Rarer plants such as Marsh Helleborine *Epipactis palustris* and Grass of Parnassus *Parnassia palustris* were also present, and growing submerged along the spring line were populations of stoneworts *Chara* sp. Along the edge of these springs there were extensive carpets of 'brown mosses' such as *Scorpidium scorpioides*. It was in the mossy areas that the single *V. lilljeborgi* was discovered.

This site is considerably more base rich than the majority from which *V. lilljeborgi* has previously been recorded and, whilst these springs do show some fluctuation in their level, this is very slight in comparison with most *V. lilljeborgi* localities. It has been suggested that *V. lilljeborgi* is not found with other *Vertigo* species (Kevan, D. K. & Waterston, A. R., *J. Conch., Lond.* **19**: (1933) pp 296–313) and it is therefore worth noting that *V. antivertigo* was also present in moss at this site. Other molluscs recorded from the same locality were: *Lymnaea truncatula*, *Oxyloma pfeifferi*, *Deroceras laeve*, *Cochlicopa lubrica*, *Euconulus alderi*, *Carychium minimum*, *Punctum pygmaeum* and *Ashfordia granulata*.

We are grateful to Dr. M. P. Kerney and A. O. Chater for confirming the identity of this specimen.

D. C. BOYCE, P. R. HOLMES and D. K. REED
Nature Conservancy Council, Plas Gogerddan, Aberystwyth, Dyfed SY23 3EE

VERTIGO MOULINSIANA, V. LILLJEBORGI AND OTHERS IN SHROPSHIRE

Vertigo moulinsiana (Dupuy) was found 17 years ago at Sweatmere in Shropshire (SJ 4330) and this record has remained an isolated one (M. P. Kerney, 1976 *Atlas of the Non-marine Mollusca of the British Isles*, ITE).

In August 1991 I carried out a survey of terrestrial molluscs at Sweatmere and at five further wetland sites in the county: Trefonen Marshes (SJ 2426), Sweeney Fen (SJ 2725), the Yesters (SJ 4322), the old bed of the River Severn near Shrewsbury (SJ 4914) and Fenemere (SJ 4423) on contract to English Nature, and at the invitation of the Conchological Society.

V. moulinsiana was again found at Sweatmere, 12 fresh shells being found along with many other molluscs in an area of sedges, rushes and developing alder and willow carr immediately behind the reed beds round the edge of the mere. Twelve other species of terrestrial snail were associated with the *V. moulinsiana*, all species commonly found in fens, and including *Oxyloma pfeifferi* (confirmed by dissection), *V. antivertigo*, *Euconulus alderi* and *Zonitoides nitidus*.

V. moulinsiana was not found in the more mature carr woodland further from open water, despite searching and collecting litter from a large area. Nor was it found any any of the other five sites, although Sweeney Fen, the old river bed and Fenemere had potentially suitable habitats. Sweatmere, now a National Nature Reserve, is well known to botanists as the classic example of a hydrosere – the succession of vegetation as a lake silts up.

A single, dead but fresh specimen of *Vertigo lilljeborgi* (Westerlund) was found at Sweeney Fen, a local nature reserve. This is a small area of relatively poor, grazed fen which has a stream flowing through it, but normally no standing water. It is fringed by hedges on two sides and a line of trees on one, with higher pastureland around. It is dominated by *Carex acutiformis*, *Juncus acutiflorus*, *J. subnodulosus* and *Filipendula ulmaria*. In all, 21 species of terrestrial snail were found in the fen, woodland species making an appearance where litter from overhanging trees falls on the fen. *V. lilljeborgi*, along with *V. antivertigo*, *V. pygmaea* and other wetland species was found away from trees, and close to the stream which flows through the fen.

Sweeney Fen, close to the Welsh border, is c130m a.s.l., a very similar altitude to the other recent most southern site reported by Chater (*J. Conch., Lond.* **32** (1985) pp 147–148) in Cardiganshire. This site is evidently more eutrophic than that in Cardigan, though some plants (e.g. *Menyanthes trifoliata* and *Juncus acutiflorus*) are common to both sites. No *Sphagnum* was seen. Judging by areas of exposed mud, and accumulations of dead plant material, the fen does flood periodically, an indicator of suitability noted by Chater. In other respects, however, this is an unusual site for this upland and northern species.

As with *V. moulinsiana*, *V. lilljeborgi* was found in one site only. Of the other sites, the Yesters is probably secondary and holds mainly species of catholic habitat preference, and the old river bed (probably extensively disturbed) is slightly richer. Fenemere has rich alder carr, but was poorest of all in terrestrial molluscs (9 species). Trefonen Marshes, a mixture of open, tufa forming, calcareous mire and lime-rich valley alder woods is rich in species despite very heavy grazing and trampling throughout. The mire yielded 13 species, all with strong wetland affinities, including *Vertigo antivertigo*, *V. substriata*, *V. pygmaea* and *Z. nitidus*. *V. substriata* was also found in moss in the woods, along with *Leiostyla anglica* and *Acicula fusca* and 20 other species, a remarkable list in view of the devastated appearance of the ground. A small fragment of tufa collected with litter also yielded a subfossil fragment of *Truncatellina* sp, but lacking the aperture.

Most other meres in Shropshire and Cheshire have been subject to extensive disturbance, and it is possible that *V. moulinsiana* has only a single refuge in this region. Small fens similar to Sweeney Fen are reasonably common in the Marches, however, and it may be that further records of *V. lilljeborgi* will be forthcoming.

I am grateful to Martin Willing for drawing my attention to the possibility of conducting the survey for English Nature, to A. C. Hearle of English Nature for information and permissions for visits, and to Dr B. Colville for advice on finding *Vertigo* spp. A full list of species at each site is contained in the report to English Nature.

R. A. D. CAMERON
School of Continuing Studies, The University of Birmingham, Birmingham B15 2TT

INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr R. C. Preece, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ.**

PAPERS Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

Journal of Conchology

Vol. 34, Part 3, May 1992

Contents

	PAGE
PAPERS	
M. FOGAN—Mollusca in Fiction (II)	119
D. HEPPELL—A Re-Evaluation of the Records of <i>Sthenoteuthis pteropus</i> (Steenstrup, 1855) (Cephalopoda: Ommastrephidae) from the British Isles	125
M. WOŁOWICZ— <i>Parvicardium hauniense</i> , An Endemic Species to Baltic Brackish Water, New to the Mediterranean Region	139
N. YONOW—The Radula of <i>Acteon tornatilis</i> (L.) (Opisthobranchia: Acteonidae)	143
M. B. SEDDON—The Distribution of <i>Pupoides coenopictus</i> (Hutton, 1834) in NW. Africa (Gastropoda: Pupillidae)	149
A. I. PUENTE and C. E. PRIETO— <i>Plentuisa vendia</i> , A New Genus and Species from the Picos de Europa (North of the Iberian Peninsula) (Gastropoda: Helicoidea: Hygromiidae)	159
B. VERDCOURT—The Identity of two Euconuloid Snails Recently Found in the Seychelles	169
C. R. C. PAUL—The Non-Marine Mollusca of Ulva, Inner Hebrides ..	175
B. VERDCOURT—The Rediscovery and Anatomy of <i>Trochonanina gwendolinae</i> (Preston) (Pulmonata: Urocyclidae)	179
COMMUNICATIONS	
INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE	183
B. VERDCOURT—Further notes on <i>Anostoma</i> (Gastropoda: Bulimulidae) ..	183
B. VERDCOURT—What is <i>Moaria chaperiana</i> Bourguignat?	184
B. VERDCOURT—Two Mascarene <i>Tropidophora</i> (Pomatiasidae) found in Tanzania	185
D. C. BOYCE, P. R. HOLMES and D. K. REED— <i>Vertigo lilljeborgi</i> Westerlund on Anglesey	185
R. A. D. CAMERON— <i>Vertigo moulinsiana</i> , <i>V. lilljeborgi</i> and others in Shropshire	186
REVIEW	148

Journal of Conchology

34, Part 4

ISSN 0022-0019

December 1992



**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN
AND IRELAND**

51 Wychwood Avenue, Luton, Bedfordshire LU2 7HT

Hon. Secretary: Mrs S. DAVIES,
5, The Deans, Portishead, Bristol BS20 8BG

Hon. Treasurer: Mr. A. SECCOMBE,
36a Selborne Road, Ilford, Essex IG1 3AJ

Hon. Editor: Dr. R. C. PREECE,
Department of Zoology, University of Cambridge,
Downing Street, Cambridge CB2 3EJ.

Member's subscription: £21 per annum. **Entrance fee:** £1.

Family membership: £23 per annum.

Institutional membership: £30 per annum.

Students membership: £10

Meetings are held at the British Museum (Natural History) at 2.30 p.m. usually on the third Saturday of each month from October to May. Field Meetings are held in the summer.

Publications: Members receive

The Journal of Conchology (usually two numbers a year).

The Conchologists' Newsletter (quarterly).

For back-numbers of these publications and special numbers please apply to Mr A. Norris, Leeds City Museum, Municipal Buildings, Leeds LS1 3AA.

Programme Secretary: Mr. I. J. KILLEEN, 163 High Road West, Felixstowe, Suffolk IP11 9BD.

Marine Census Recorder: Mrs. J. LIGHT, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN.

Non-marine Census Recorder: Dr. M. P. KERNEY, Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD.

Newsletter Editor: Mr. P. LEE, Rochdale Cottage, Camps Heath, Lowestoft, Suffolk NR32 5DW.

COVER DESIGN: *Muricanthus nigrinus* (Phillippi) by D. G. Reid.

NOTICE

Payment by Overseas Members

Overseas members are reminded that all monies due to the Society are payable in sterling.

THE MARGINELLIDAE OF ANGOLA: THE GENUS *VOLVARINA*

S. GOFAS¹ AND F. FERNANDES²

(Accepted for publication, 21st March, 1992)

Abstract: The species of the genus *Volvarina* (Gastropoda, Marginellidae) from coastal Angola are reviewed. *V. ameliensis* (Tomlin, 1917) is representative of a complex including several similar morphotypes, among which *V. riparia* n. sp. is recognized as a distinct species; further research may lead to the recognition of more species. Two other new species, *V. fugax* and *V. peregrina*, not related to this complex, are also described.

Résumé: Les espèces du genre *Volvarina* (Gastropoda, Marginellidae) du littoral de l'Angola sont révisées. *V. ameliensis* (Tomlin, 1917) est représentative d'un complexe comprenant des morphotypes très similaires, parmi lesquels nous reconnaissons *V. riparia* n. sp. comme espèce distincte; des recherches à venir pourraient permettre de reconnaître d'autres espèces. Deux autres espèces nouvelles, *V. fugax* et *V. peregrina*, qui n'entrent pas dans ce groupe, sont aussi décrites.

Resumo: As espécies do género *Volvarina* (Gastropoda, Marginellidae) do litoral de Angola são revistas. *V. ameliensis* (Tomlin, 1917) é representativa de um complexo de morfotipos muito similares, entre os quais reconhecemos a *V. riparia* como espécie distinta; é possível que as pesquisas ulteriores permitam reconhecer mais espécies. Outras duas espécies novas, *V. fugax* e *V. peregrina*, não relacionadas com este grupo, são também descritas.

Keywords: Taxonomy, Marginellidae, West Africa, endemism

INTRODUCTION

This paper continues a revision of Angolan marine gastropods of the family Marginellidae, initiated with the genus *Gibberula* (Gofas 1989a). The reader is referred to the latter paper for collecting methods and a map of collecting localities.

GENUS *VOLVARINA* HINDS, 1844

The type species of *Volvarina* is *Marginella nitida* Hinds, 1844 (subsequent designation by Redfield, 1871); a neotype of *M. nitida* is figured by Gofas (1989b) and the taxon is considered a synonym of the Mediterranean *V. mitrella* (Risso, 1826). Hinds' (1844: 75) comment "*M. avena* is a typical species" is not a designation of a type species under ICZN code (art. 67C, 1,2). The designation of *Volvaria triticea* Lamarck, 1822 as the type species by Cossmann (1899: 92) is invalid.

Shell characters: Shells 5 to 20 mm in length, oblong, smooth with a glossy superficial varnish. Spire low to moderate with a rounded apex; body whorl occupying most of the shell length.

Columella with four plaits in the anterior half, decreasing in size anteriorly; a much

¹ Muséum National d'Histoire Naturelle, Laboratoire de Biologie des Invertébrés marins et Malacologie, 55 rue Buffon, F-75005 Paris, France

² C. P. 1038, Luanda (Angola)

weaker fifth anterior plait in some species. Outer lip thickened (in adults), always smooth internally and sometimes bordered externally by a slight varix. Aperture terminating anteriorly in a broad, un-notched siphonal canal.

Shell colour uniform, or with spiral bands; shell translucent in the small species.

External characters of the animal: Head bifurcated, with slender tentacles and eyes situated in small bulges laterally to the base of the tentacles. Siphon large, protruding over the head.

Foot crawling flat on the substrate, very large, longer than the shell when extended, and tapering posteriorly.

Mantle covering the shell completely when the animal is moving or undisturbed, pustulose on the outer surface. Pattern of the inner mantle visible through the shell when the outer mantle is retracted.

Head, foot and mantle with species-specific colour patterns combining yellow, orange, various shades of brown, or black.

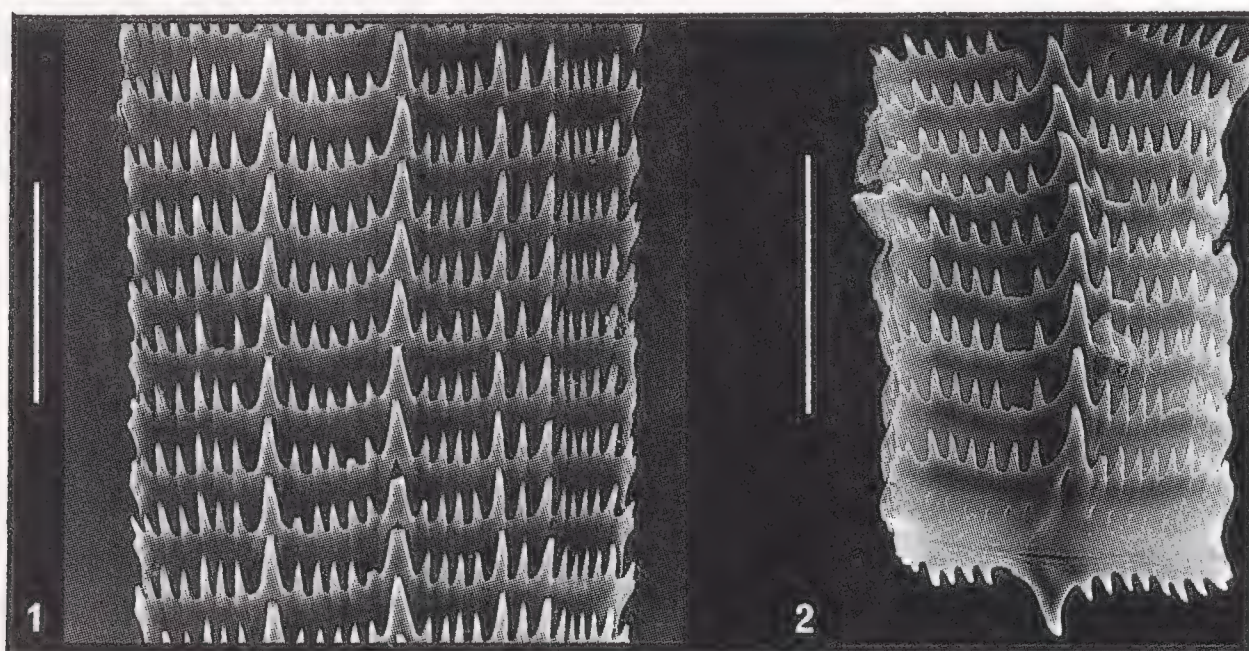
Radula: composed of a single row of comb-like teeth, each with 15–30 cusps. In the type species *V. mitrella* (Gofas, 1989b: 161), *V. ameliensis* (Tomlin, 1917) (Coover 1990: 6–7) and *V. riparia* n. sp., larger cusps alternate with groups of smaller cusps all across the tooth (Fig. 1). In other species, such as *Volvarina insulana* Gofas & Fernandes, 1988 from São Tomé, there is one more prominent central cusp, and smaller cusps on either side (Fig. 2).

Coover (1990) has described the radula of many species of *Volvarina*, with some of them (e.g. *V. ameliensis* (Tomlin, 1917), *V. capensis* (Krauss, 1848), *V. cf. deliciosa* (Bavay in Dautzenberg, 1913)) assigned to the genus *Prunum* Herrmannsen, 1852 and others to *Volvarina* on the basis of shell morphology.

Anatomy of related marginellid genera: Fretter (1976) has described the anatomy of a western American species of *Volvarina*.

The genus *Hyalina* Schumacher, 1817 (type species by monotypy: *H. pellucida* Schumacher, 1817) is conchologically similar to *Volvarina*, but is anatomically distinct and lacks a radula (Coan & Roth 1976).

The genera *Prunum* Herrmannsen, 1852 (type species by monotypy and tautonymy: *Voluta prunum* Gmelin, 1791) and *Egouena* Jousseume, 1875 (type species by tautonymy: *Egouena egouen* Jousseume, 1875 = *Marginella amygdala* Kiener, 1841) differ essentially by their larger size and the presence of a pronounced varix on the outer lip of the shell. Some Angolan species (e.g. *V. riparia* n.sp.) somewhat resemble *Prunum* in having a slightly thickened external varix but we do not agree with Coover (1988) that this is enough to



Figs. 1–2. Radulae of *Volvarina*. 1: *V. riparia* n.sp., specimen from bay of Lucira. 2: *V. insulana* Gofas & Fernandes, 1988, specimen from Espirinha, island of São Tomé. Scale bars are 100 μm .

separate them at generic level from *Volvarina*. The radula and external characters of the living animal are not, essentially, different in *Prunum* and *Volvarina*. Their separation is subjective and at the present state of knowledge is based mostly on size. A number of large American species may prove to be a homogeneous group correctly assigned to *Prunum*.

Distribution: Species of *Volvarina* are found on the shelf and slope of tropical seas and occasionally in temperate regions. The highest number of species is found in the Caribbean, the Cape Verde Islands, Western and Southern Africa, and in the Northern part of the Indian Ocean. The genus is represented in the Mediterranean, the islands of the NE Atlantic, in SE Asia and West America.

The Angolan species of *Volvarina* are all endemic. A different set of species is found from Mauritania to Guinea, and only one in Cameroun and Gabon.

Volvarina ameliensis (Tomlin, 1917) (Figs. 3–4, 17)

Marginella bivittata Bavay, in Dautzenberg, 1913, p. 23, pl. 1, fig. 23–24

Marginella ameliensis Tomlin, 1917 (replacement name).

Type material: The specimen in the Muséum National d'Histoire Naturelle, Paris (MNHN) figured in Dautzenberg (1913), here designated as the lectotype.

Type locality: Praia Amelia (15°12'S, 12°07'E), province of Namibe, Angola, 15–35 m.

Other material examined: Praia Amelia, 1 specimen and 1 shell (MNHN), and 7 specimens (FF). Bay of Lucira (Bissonga), on rocks 1 m: 1 juvenile specimen. Bay of Limagens, 1 specimen (MNHN).

(*Volvarina* cf. *ameliensis*): Bay of Lucira (Bissonga), on rocks 1 m: 1 specimen (MNHN). Bay of Lucira (Cesar), 12 m: 7 shells (MNHN). Bay of Baba 20–30 m: 9 specimens (MNHN). Praia Amelia, 40–60 m: 17 shells (MNHN).

Description

Shell: 7 to 9 mm in length (lectotype 8.1 × 4.3 mm), oblong with short conical spire. Outer lip with a distinct rim, bordered externally. Columella with four strong plaits occupying the anterior half; the two foremost slightly thicker and closer together. Colour yellowish gray,

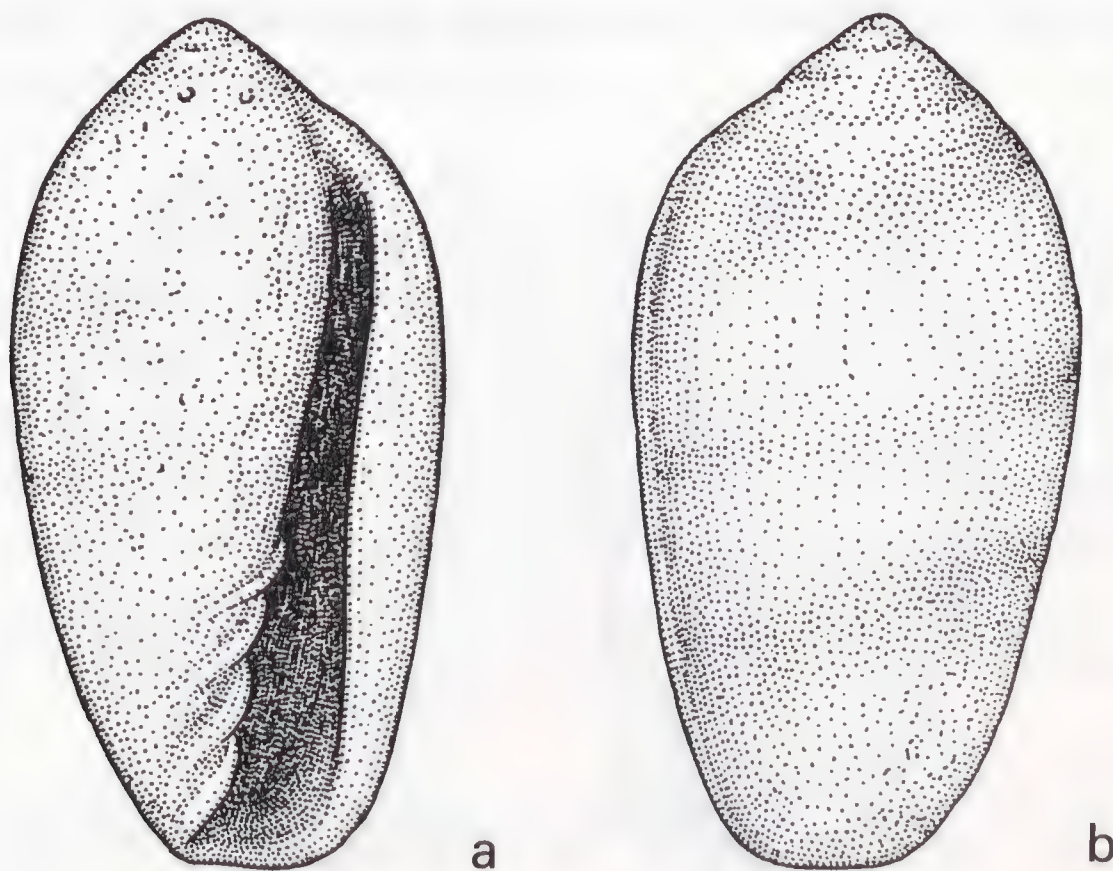


Fig. 3 a,b. *Volvarina ameliensis* (Tomlin): lectotype, Praia Amelia, 15–35 m (8.1 × 4.3 mm).

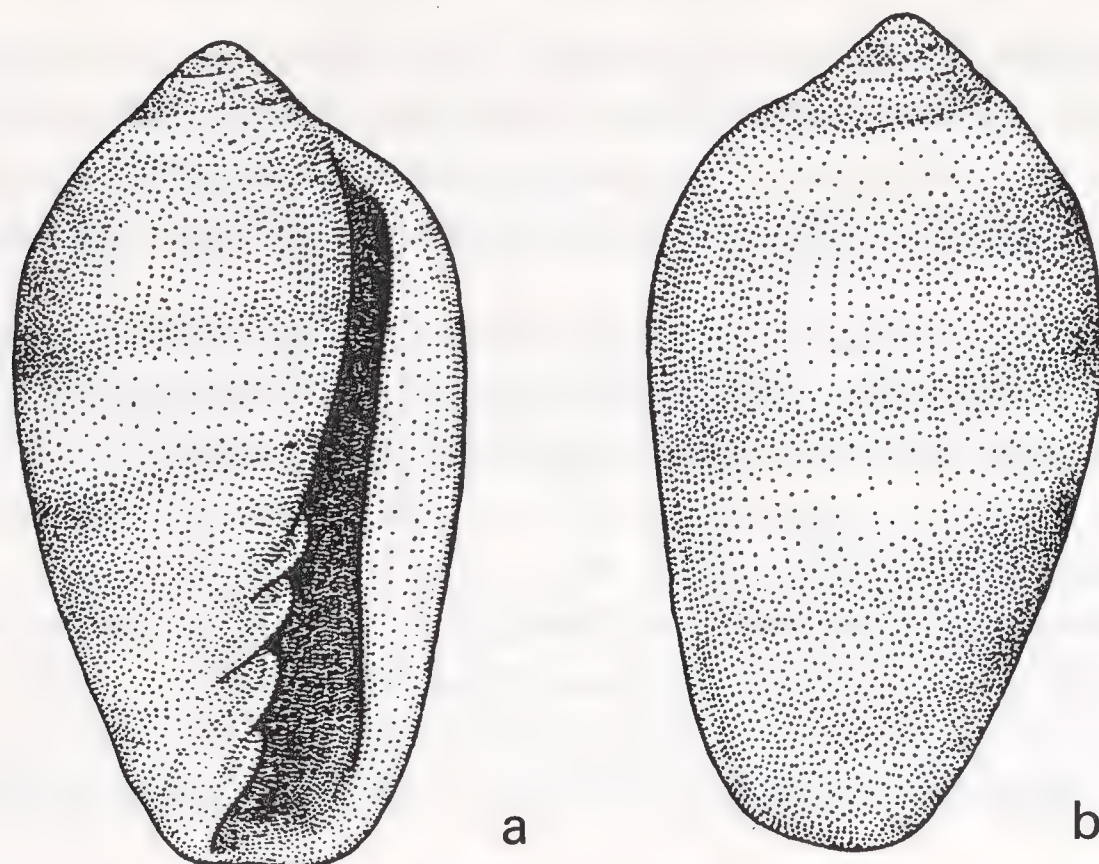


Fig. 4 a,b. *Volvarina ameliensis* (Tomlin): Praia Amelia, 2–5 m (7.9×4.4 mm; same specimen as Fig. 17).

with two blurred, tawny, spiral areas anterior and posterior to a whitish band on the body whorl; the immediate border of the pale band forming two darker lines. Area along the suture paler.

Foot: rather broad and stout, covered with crowded, rusty and yellow dots; the latter merging together towards the inner part of the foot to form irregular yellow areas. Axis of metapodium with a conspicuous brown line, propodium with a brown streak on either side. Head colourless around the eyes; tentacles with large yellow and rusty orange streaks.

Outer mantle: pustulose, predominantly blackish to dark brown, also with yellow and rusty orange spots; the edge paler except for some distinct brown spots. Siphon covered with brown and yellow spots, except on the tip which is bordered with orange spots. Inner mantle, which is visible through the shell, is covered with brown, orange and yellow spots.

Remarks: This description is based on the lectotype and on specimens collected alive in the type locality. The latter (Figs. 4, 17) are all somewhat darker with two bands and a white zone more clearly defined. The lectotype is an old shell in which the original colour may have faded. One specimen collected at Limagens has the same colour patterns of shell and animal as found in Praia Amelia.

A specimen from the bay of Lucira, dredged subtidally in 5–10 m (Figs. 5, 14), agrees

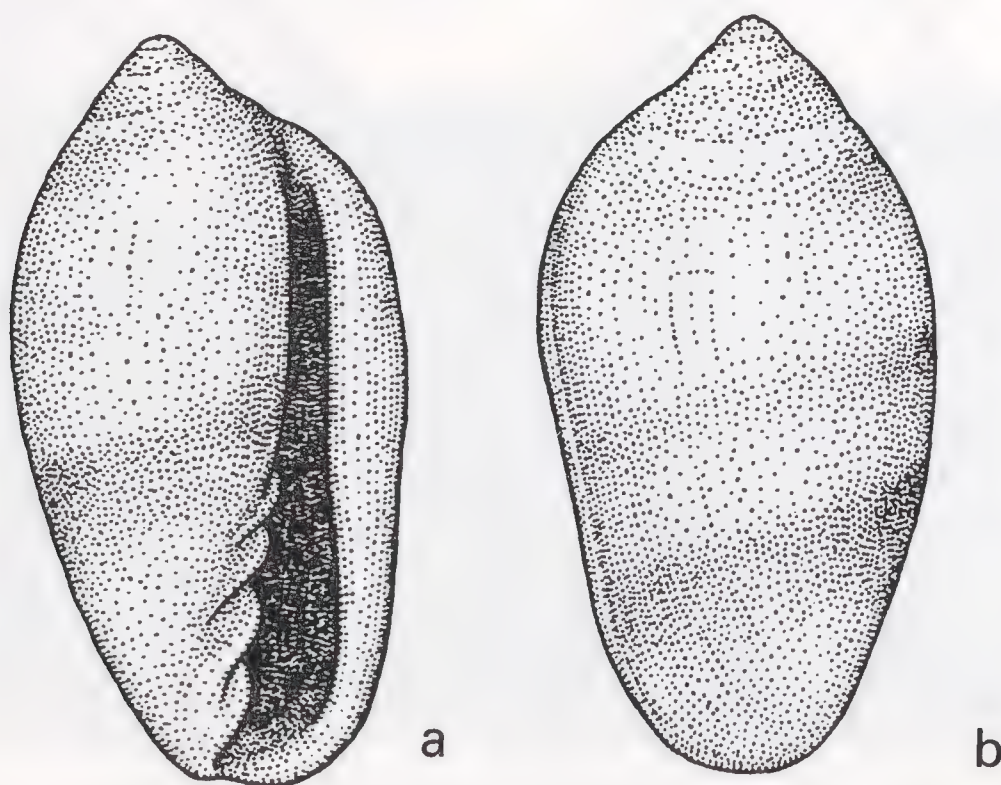


Fig. 5 a,b. *Volvarina* cf. *ameliensis*; Bay of Lucira, 2 m (7.2×3.8 mm; same specimen as Fig. 14).

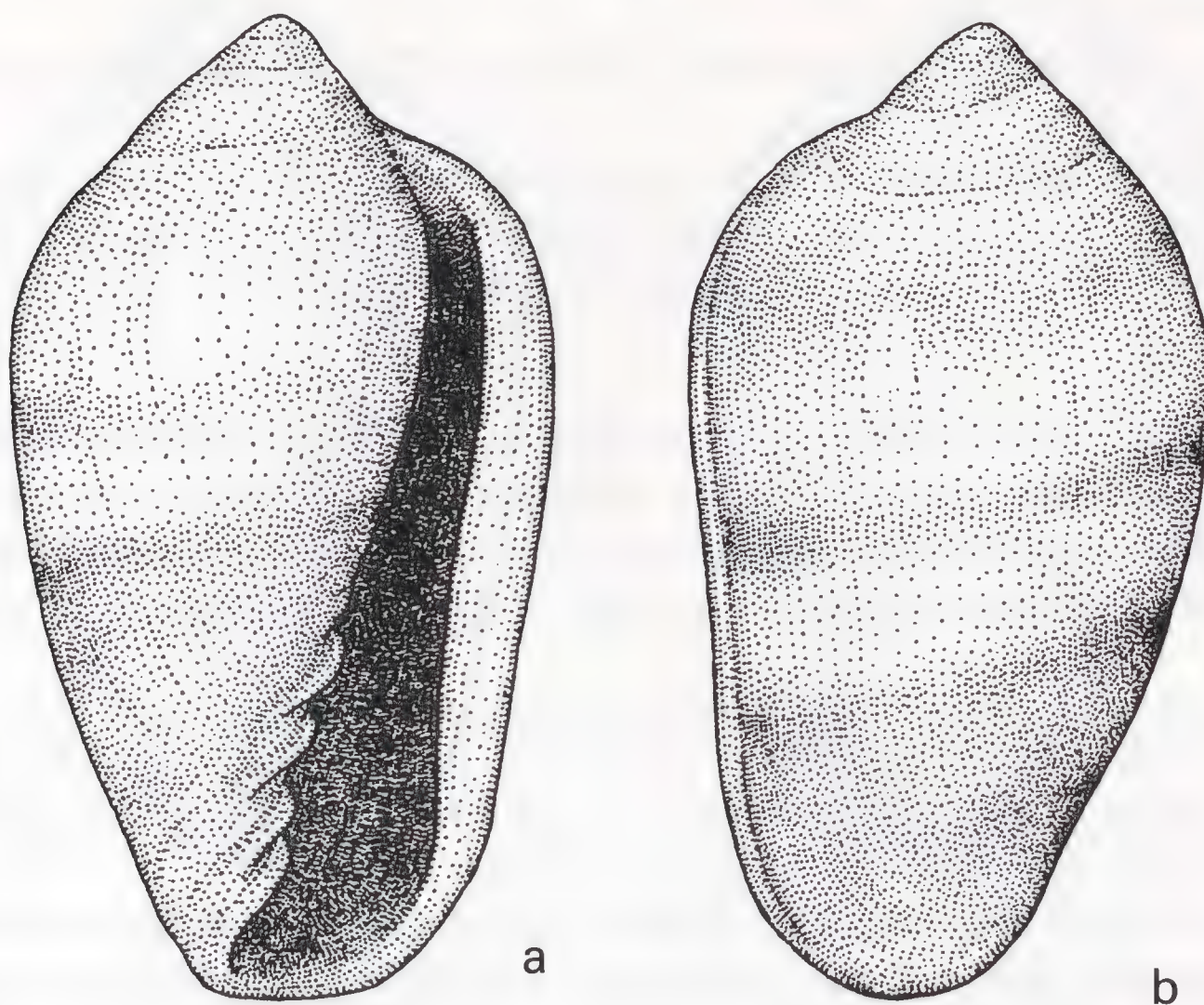


Fig. 6 a,b. *Volvarina* cf. *ameliensis*: Bay of Baba, 20–30 m (10.0 × 5.3 mm).

quite well with the lectotype in shape and shell colour. It differs from specimens observed alive in Praia Amelia in that the foot has more yellow and very few orange dots, brighter in colour; the siphon is covered all over (not only on the tip) with orange spots and lacks the dark band.

A larger form (Fig. 6) is found in deeper water (20–50 m). It reaches over 10 mm in length and has a more shouldered outline, but otherwise matches the general morphology and colour pattern of *V. ameliensis*. It is tentatively considered conspecific, although the animal has not been observed alive.

It is likely that more than one species is involved in a complex including *V. ameliensis*. At this time, we have not seen enough living specimens to introduce, formally, any new taxa except *V. riparia* n.sp. which is discussed further.

Volvarina capensis (Krauss ex Dunker Ms., 1948) differs conchologically from *V. ameliensis* and from *V. riparia* n.sp. by lacking a distinct external rim on the outer lip, by a more regularly fusiform shape (not shouldered), by the anterior plaits which are thinner and not twinned, and by the horny appearance of the shell material. *Marginella cantharus* Reeve, 1865, described without locality data, is here regarded as a synonym of *capensis*. *Marginella walwisiana* Tomlin, 1920, at this time known only from its type material, is a larger form related to *V. capensis*, and differing from the Angolan species by the same characters.

Habitat: At Praia Amelia, all specimens were found in the algal mat with sediment covering rocks at 2–5 m depths.

***Volvarina riparia* n.sp. (Figs. 8, 18)**

Type material: Holotype and 11 paratypes (9 adult specimens and 2 juveniles) from the type locality (6 MNHN, 1 BMNH, 1 IIT, 1 UAN). Paratypes: Caotinha, 6 specimens and

juveniles (MNHN). Bay of Limagens, 2 specimens (MNHN). Bay of Santa Maria, 15 specimens (5 MNHN, 10 FF).

Type locality: Bay of Lucira (Praia do Cesar, 13°52'S, 12°30'E), province of Namibe, Angola.

Other material examined (all MNHN): Ponta das Lagostas, 2–10 m: 1 specimen and 12 shells. Bay of Santa Maria, one specimen (colour variant). São Nicolau, 1 shell. Moçâmedes, strandline near Salinas, 6 specimens (alcohol). Praia Amelia 1–2 m: 2 specimens.

Description

Shell: 7.5 to 10 mm in length (holotype 9.3 × 5.5 mm), oblong with short conical spire. Outer lip strongly thickened, bordered externally. Columella with four strong plaits occupying the anterior half; the two foremost fused together to form a ridge. Colour yellowish gray, with two very pale tawny lines running over the body whorl. Area along the suture porcellaneous and clear.

Foot: rather broad and stout, covered with crowded brown, orange and yellow dots; the latter coalesce towards the inner part of the foot to form irregular yellow areas. There is a faint brown streak on either side of the propodium. Head tinged with black behind the eyes; tentacles with brown (few), yellow and orange spots.

Outer mantle: pustulose, with large, irregular dark streaks mixed with greenish, and paler areas with orange and yellow spots. Inner mantle seen by transparency, covered with black and yellow angular spots, with very few orange spots. Siphon with yellow, brown and (few) orange spots; tip bordered with opaque white.

Remarks: Weinkauff (1880; 48) first used the name *Marginella evanida* Sowerby, 1847 for this species, with the locality "Unterguinea-Benguela" and the comment "uncertain species". This name also appears on a manuscript label by Jousseume in MNHN, with specimens that seem of the same origin as his *Marginella benguelensis* (see Gofas, 1989a: 122). The holotype of *M. evanida* (BMNH 1880.9.18.9, unknown locality) is an adult shell judging from the very thickened outer lip, but much smaller (6 mm) than any specimen of this shape we have seen in Angola; it is an old shell with an opaque texture, possibly a fossil (Fig. 7). We do not consider that this name could be used for the species discussed here.

Volvarina sauliae (Sowerby, 1847) from the Cape Verde Islands is similar in shape and size, but differs in having the spiral lines continued on the outer lip by two brown blotches, unlike any of the species in the *V. ameliensis* complex, where the varix is colourless.

Some shells of *Volvarina ameliensis* are very similar to those of *V. riparia* n. sp. The shells of

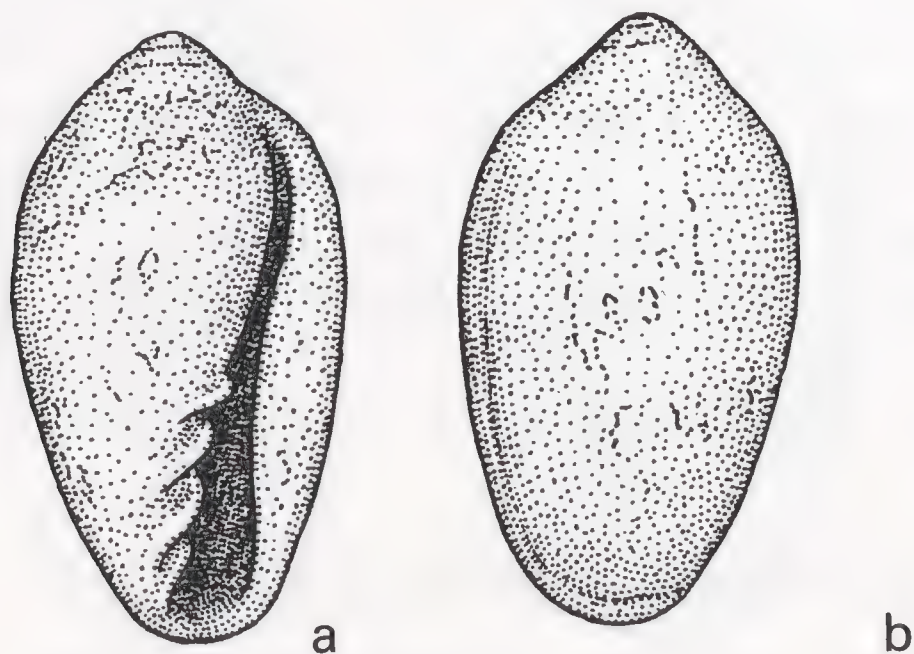


Fig. 7 a,b. *Volvarina evanida* (Sowerby): holotype (5.9 × 3.2 mm; BMNH 1880.9.18.9), unknown locality.

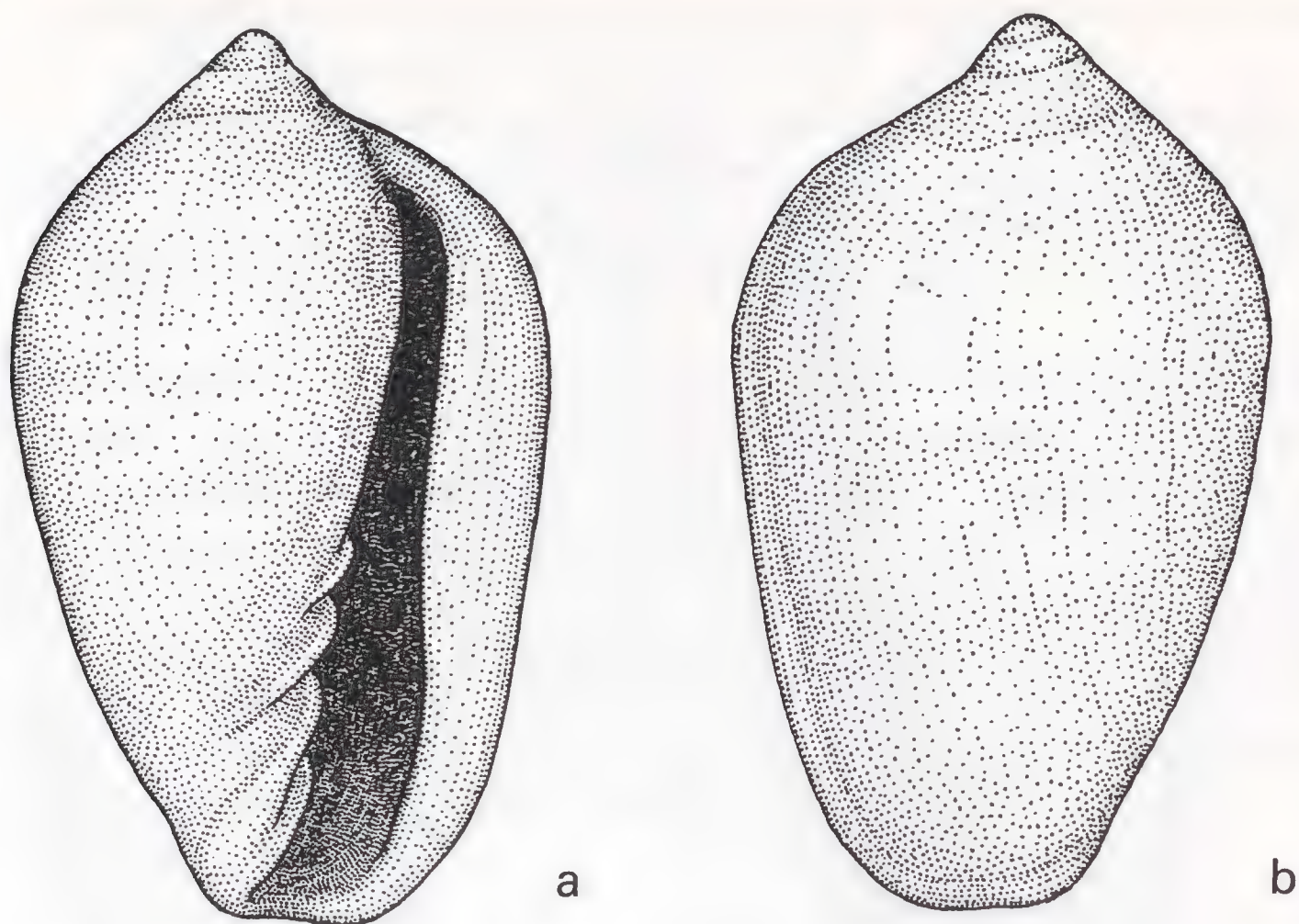


Fig. 8 a,b. *Volvarina riparia* n.sp.: holotype, Bay of Lucira, 1 m (9.3×5.5 mm; also Fig. 18).

V. riparia are stouter, with a thicker outer lip and paler colour banding, consisting only of the two spiral lines on the body whorl. The most consistent difference, after which we decided to treat them as a separate species, is in the colour pattern of the animal: *V. riparia* differs in having both brown and orange spots on the tentacles and foot, in lacking the dark stain on the metapodium and in having greenish pigments on the outer mantle.

One specimen from Santa Maria has a shell of pale lilac colour; it is assigned to this species as it otherwise agrees in general shape, and colour of the animal.

Habitat: *V. riparia* n.sp. lives in the thin sand layer covering the edge of rocky ledges, in 1–2 m water depth of quiet bays. Of the species described here, it inhabits the shallowest waters.

Volvarina angolensis (Odhner, 1923) (Fig. 9)

Marginella angolensis Odhner, 1923, pl. 1 fig. 18–19

Type material: (Göteborgs Naturhistoriska Museum, Sweden): Lectotype, here designated [fig. 19 of Odhner, 1923, registered as “holotype” Gastrop. 3552] and one paralectotype [Gastrop. 3553]

Type locality: off Porto Alexandre, province of Namibe, Angola, ca. $15^{\circ}43'S$, $11^{\circ}54'E$, 73 m (40 fathoms).

Description

Shell: 11 to 12 mm in length (lectotype 11.4 mm), oblong and slender with conical spire. Outer lip thickened, bordered externally. Columella with four rather thin plaits occupying the anterior portion. Colour uniformly whitish, with the area along the suture rather porcellaneous.

Remarks: This species is known only from the type material. One shell, resembling *V. angolensis*, but much larger (16 mm) has been found off Ilha de Luanda, in the 80 m-deep line of littoral debris; it is likely therefore to be a Pleistocene fossil.

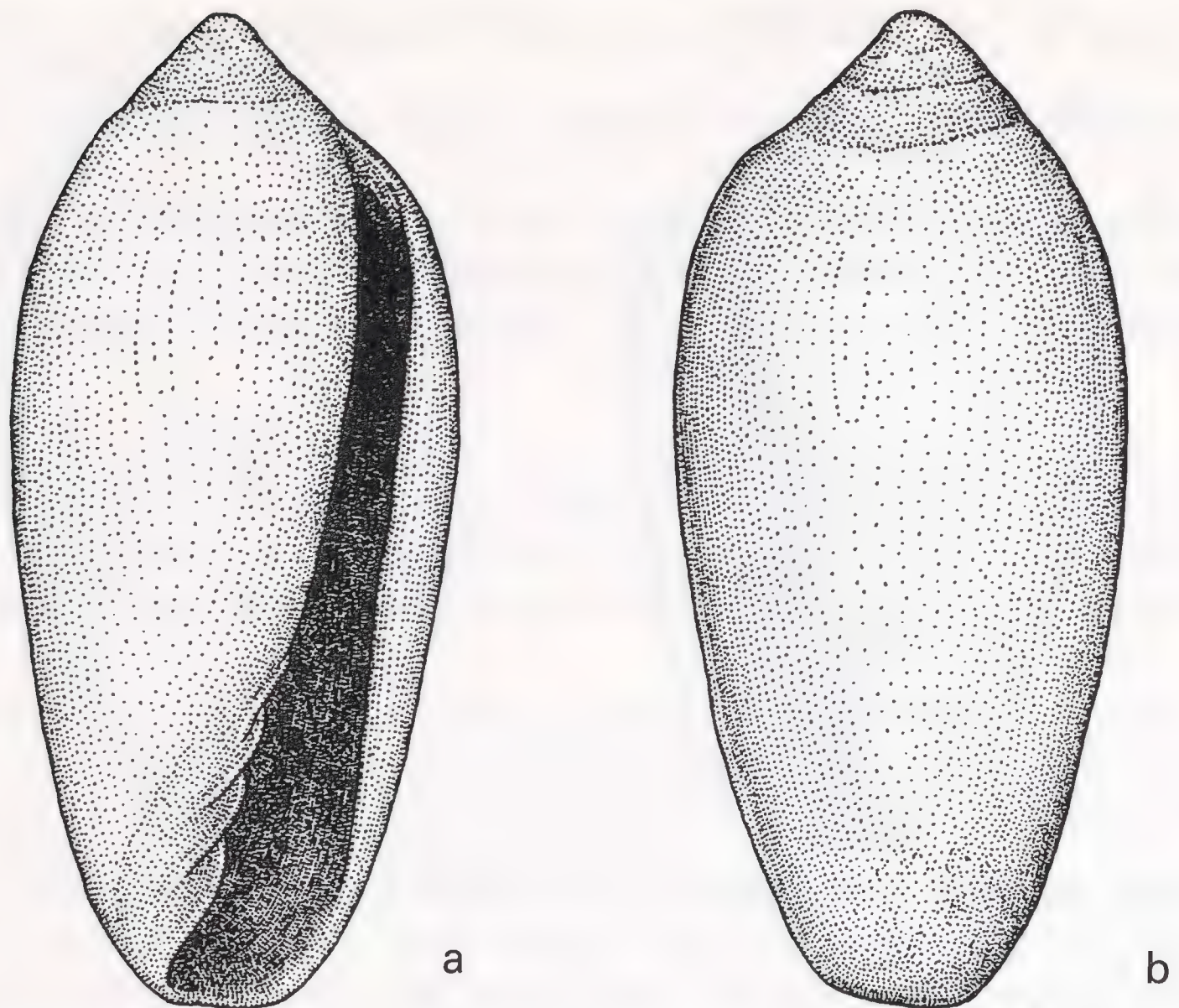


Fig. 9 a,b. *Volvarina angolensis* (Odhner, 1923), lectotype (11.4×5.2 mm), off Porto Alaxandre, 73 m (40 fathoms).

Volvarina fugax n.sp. (Figs. 10, 16)

Type material: Holotype (MNHN) and 8 paratypes (4 MNHN, 1 BMNH, 1 IIT, 1 UAN, 1 FF) from the type locality.

Type locality: Santa Marta ($13^{\circ}52'S$, $12^{\circ}25'E$), province of Namibe, Angola, 40 m.

Description

Shell: 6.5 to 8 mm in length (holotype 6.9×3.5 mm), slender, slightly tapering anteriorly. Spire moderately low. Outer lip with a thin rim, bordered externally. Colour translucent white with a pale tawny line running on the anterior third of the body whorl.

Foot: rather large, tapering posteriorly to a sharp point, covered with crowded orange and yellow dots; the latter merging together towards the inner part of the foot to form irregular yellow areas. Metapodium with a conspicuous brown line over the axis; propodium with

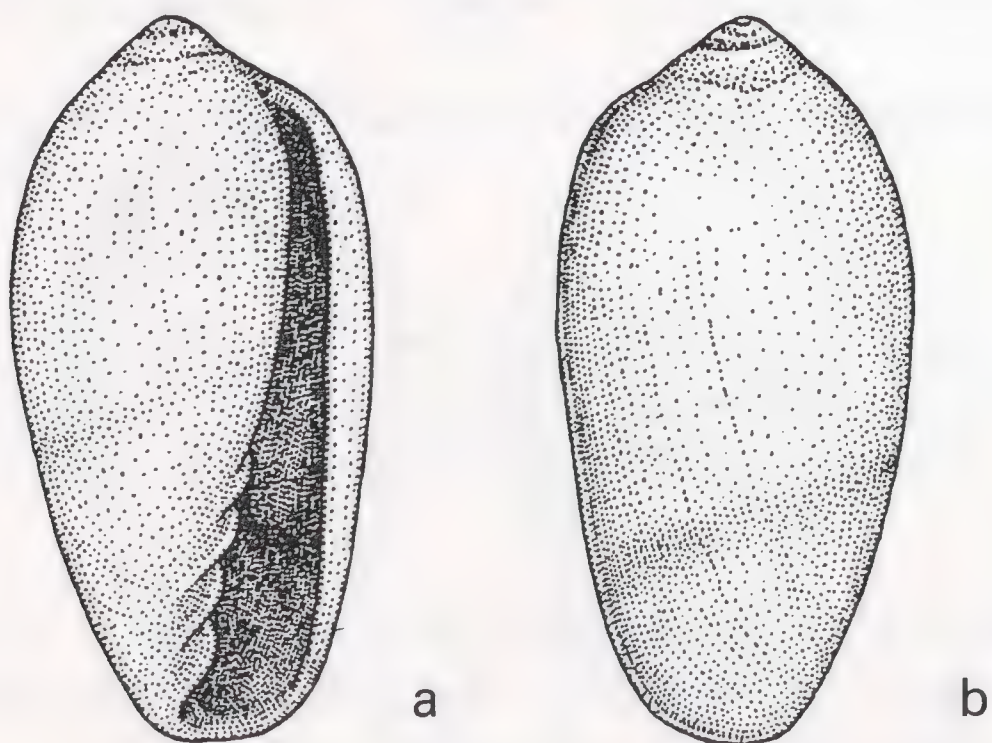


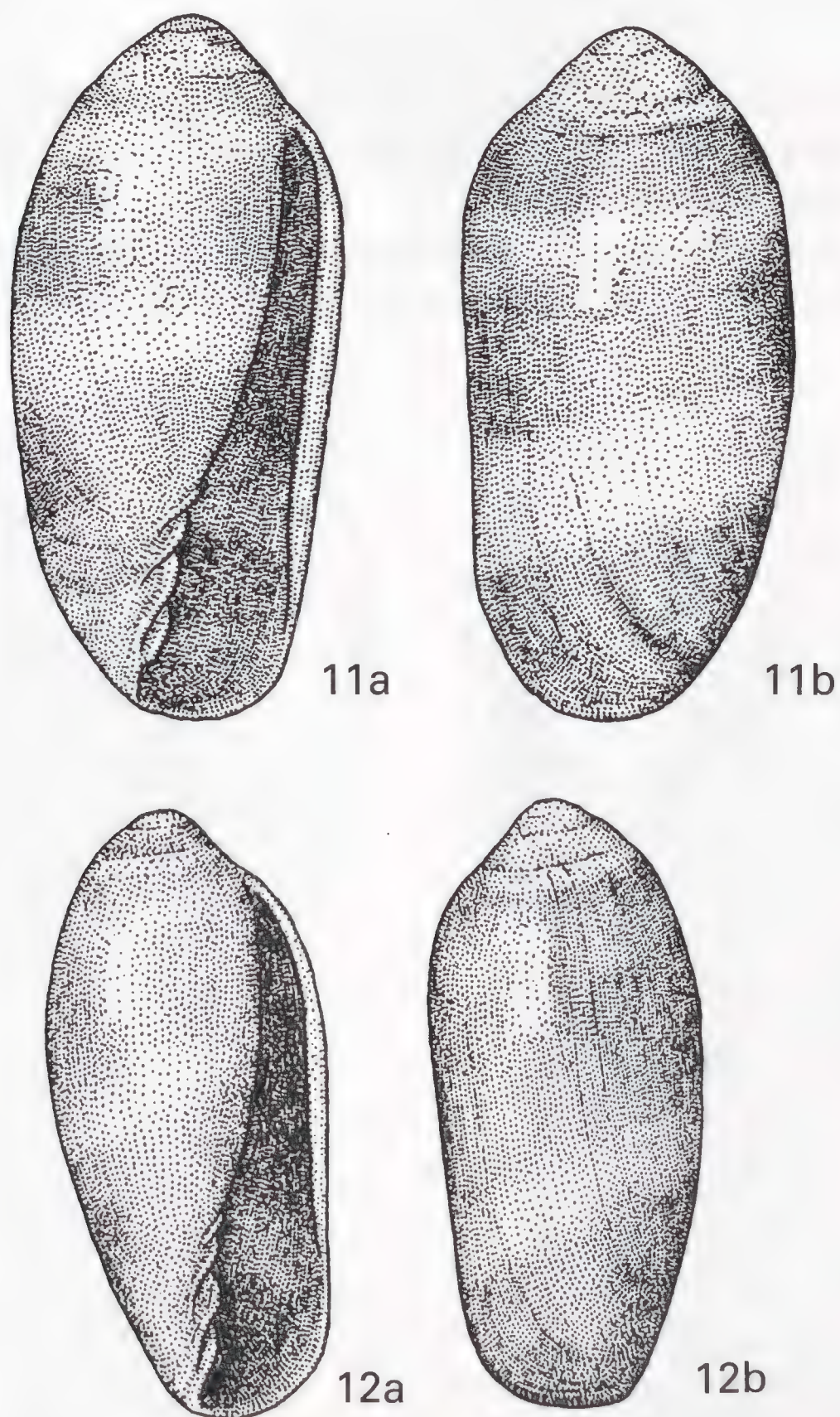
Fig. 10 a,b. *Volvarina fugax* n.sp.: holotype, Santa Marta, 40 m (6.9×3.5 mm; also Fig. 16).

similar brown "whiskers". Head rather small for the genus, colourless around the eyes; tentacles with yellow and orange dots evenly distributed.

Outer mantle: with predominantly rusty-orange spots, more or less coalescent, few dark brown spots, many yellow pustules all over, and reddish-brown spots along the edge. Siphon rather small, covered with dense rusty-orange spots. Inner mantle seen by transparency, mostly with small orange and yellow spots, and a limited brown streak.

Remarks: This species differs from all other described here by the proportions of the animal to the shell: the head and siphon are comparatively smaller, and the extended foot, larger.

It closely resembles *Volvarina unilineata* Jousseaume, 1875, a taxon based on a shell of unknown origin (Cuming collection) figured by Reeve (1865: pl. 17, No 79) and incorrectly assigned by him to *Marginella fusiformis* Hinds, 1844. The holotype in the BMNH is larger (10.8 mm) with a thicker rim on the outer lip and a much more salient spire, and matches some specimens from off NW Africa (MNHN). I consider it unlikely that the latter is conspecific with the Angolan species; a confirmation of this view may only be possible when live specimens of Mauritanian populations can be studied.



Figs. 11–12. *Volvarina peregrina* n.sp.:
11 a,b. holotype (8.1 × 3.8 mm; also fig. 15), Praia Amelia, 2–5 m.
12 a,b. paratype (7.0 × 3.3 mm), Bay of Santa Maria, 8–10 m.

Volvarina peregrina n.sp. (Figs. 11–12, 15)

Type material: Holotype (MNHN) and 11 paratypes from the type locality (1 MNHN, 10 FF). Bay of Mucuo, 3 paratypes (1 BMNH, 1 IIT, 1 UAN). Bay of Santa Maria: 4 paratypes (MNHN).

Type locality: Praia Amelia, province of Namibe, Angola, 15°13'S, 12°07'E, rocks at 2–3 m.

Description

Shell: 7 to 8.5 mm in length (holotype 8.1 × 3.8 mm), oblong, rather inflated. Spire moderately low and bluntly rounded. Outer lip thin, curled inwards and without an external rim. Columellar plaits narrow, reflected anteriorly parallel to the axis of the columella. Colour brown with a paler band on the anterior third of the body whorl, and another less distinct paler band on its posterior quarter; sutures whitish.

Foot rather short for the genus, evenly covered with orange, yellow and black spots. Head colourless around the eyes; tentacles with yellow and black spots only, evenly distributed.

Outer mantle pustulose, with orange, yellow and black spots, the two latter kinds being larger towards the edge. Siphon comparatively large, densely mottled with black (dominant), yellow and orange rusty orange spots. Inner mantle seen by transparency, mostly with pale orange and yellow spots.

Remarks: This species is not closely related to the other Angolan *Volvarina*. It is more similar, conchologically, to species from the Cape Verde Islands, or from the Azores (Gofas, 1989: 180) than to any sympatric species.

A smaller species with a shell of similar shape, entirely white, has been found in Bay of Santa Maria, Benguela (Fig. 13). We prefer not to name it until the animal is known.

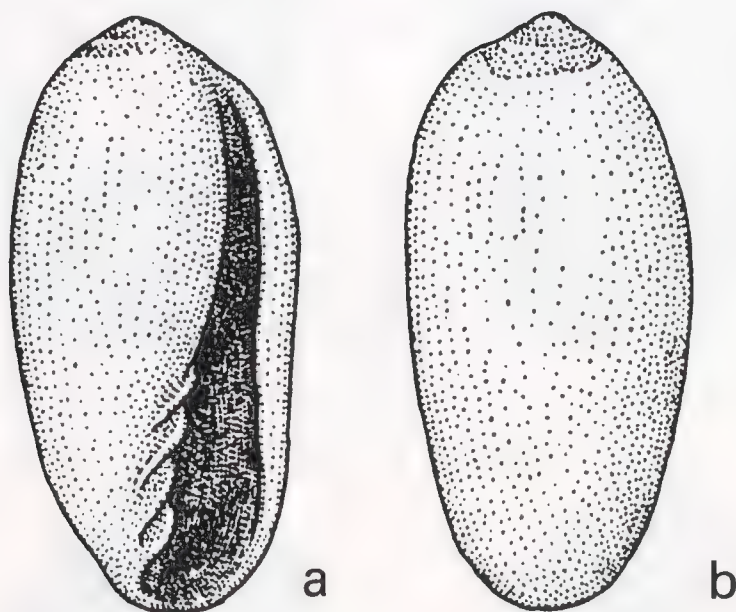


Fig. 13 a,b. *Volvarina* sp.: Santa Maria, 8–10 m (5.8 × 2.3 mm).

Figs. 14–18 (opposite). Living animals of *Volvarina*.

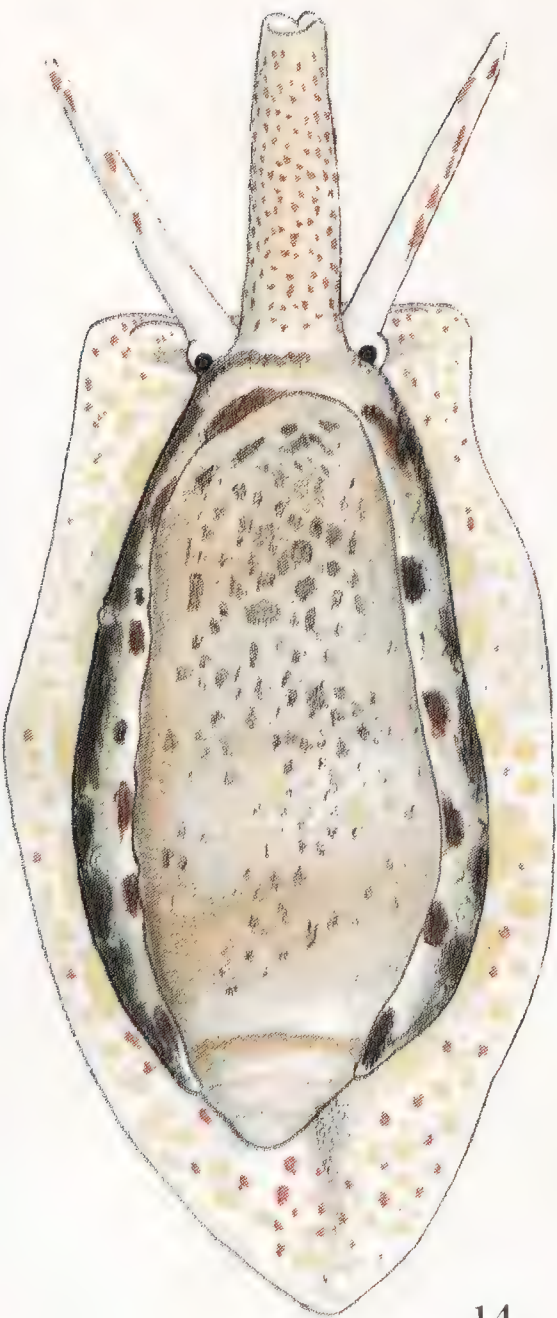
14. *Volvarina* cf. *ameliensis* (Tomlin): Bay of Lucira, 2 m.

15. *Volvarina peregrina* n. sp.: holotype, Praia Amelia, 2–5 m.

16. *Volvarina fugax* n. sp.: holotype, Santa Marta, 40 m.

17. *Volvarina ameliensis* (Tomlin): Praia Amelia, 2–5 m.

18. *Volvarina riparia* n. sp.: holotype, Bay of Lucira, 1 m.



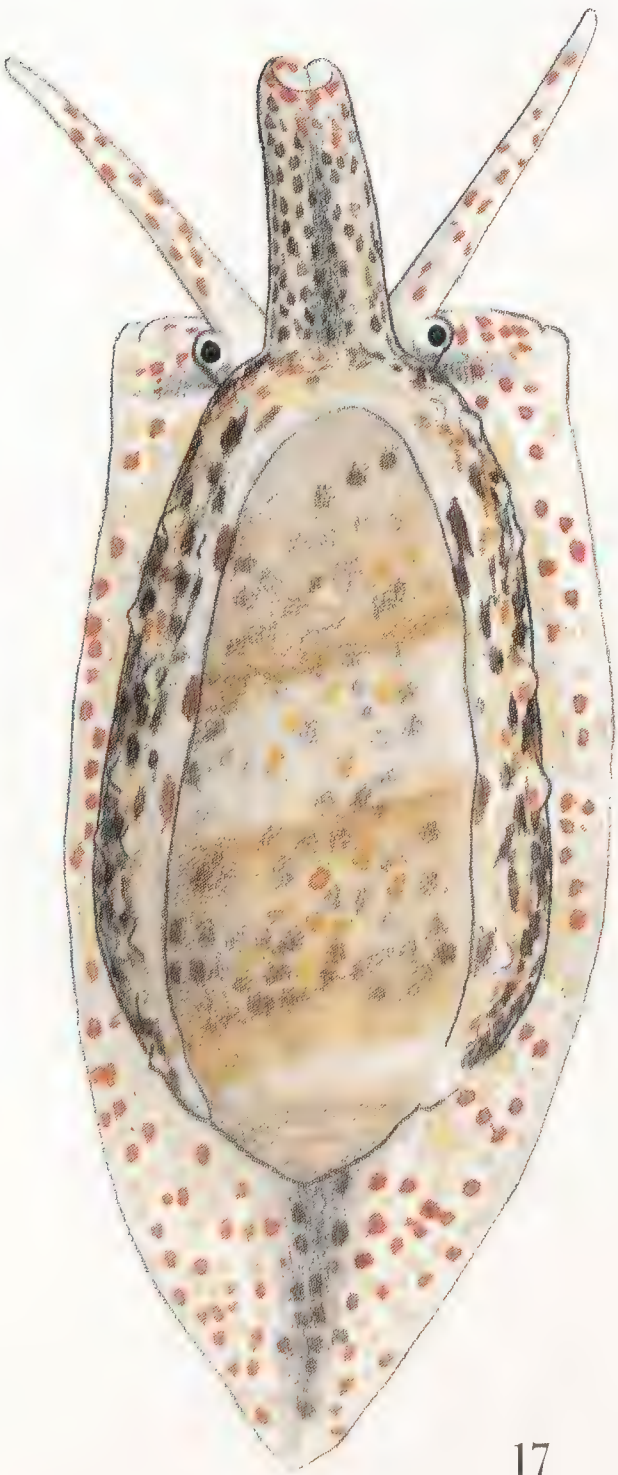
14



15



16



17



18

ACKNOWLEDGEMENTS

The authors are grateful to the authorities of Universidade Agostinho Neto of Luanda, especially to Eng^o Abilio Fernandes, Dean of Faculty of Sciences, and Dr. Eduardo Morais, head of the Geology Department, for assistance in organizing the field trips. Thanks are expressed to Dr. Anders Warén (Swedish Museum of Natural History) for mounting the radulae. The S.E.M. photographs were taken at the Laboratoire d'évolution des êtres organisés (CNRS) by Mrs. Guillaumin, under supervision of Dr. Philippe Bouchet (MNHN, Paris). The authors also express thanks to the referee for comments and corrections of the English.

REFERENCES

- COAN, E. & ROTH, B., 1976. Status of the genus *Hyalina* Schumacher, 1817 (Mollusca, Gastropoda). *J. moll. Stud.* **42**: 217–222.
- COOVERT, G., 1988. Marginellidae of Florida, part II: *Prunum succinea* with a discussion of *Prunum* and *Volvarina*. *Marginella Marginalia* **4** (5): 35–42.
- , 1990. A study of Marginellid radulae. Part I: type 6 radula, “*Prunum/Volvarina*” type. *Marginella Marginalia* **8–9**: 1–68.
- COSSMANN, M., 1899. *Essais de Paléoconchologie comparée*, livraison 3. 201 p., 8 pl. Paris.
- DAUTZENBERG, P., (“1912”) 1913. Mission Gruvel sur la côte occidentale d’Afrique (1909–1910): Mollusques marins. *Ann. Inst. Oceanogr.* **5**, (3): 1–111, pl. 1–3.
- FRETTER V., 1976. The anatomy and feeding of the volutacean prosobranch *Volvarina taeniolata* Mörch. *J. moll. Stud.* **42** (3): 327–336.
- GOFAS, S., 1989a. The Marginellidae of Angola: the genus *Gibberula*. *J. Conch., Lond.* **33**: 109–139, 63 fig.
- , 1989b. Le genre *Volvarina* (Marginellidae) en Méditerranée et dans l’Atlantique du Nord-Est. *Boll. Malac.* **25** (5–8): 159–182.
- & FERNANDES, F., 1988. The Marginellids of São Tomé, West Africa. *J. Conch., Lond.* **33**: 1–30, 31 fig, 2 col. pl.
- HINDS, R. B., 1844. Descriptions of *Marginellae* collected during the voyage of H.M.S. Sulphur, and from the collection of Mr. Cuming. *Proc. Zool. Soc., Lond.* **12**: 72–77.
- JOUSSEAUME, F. P., 1875. Coquilles de la famille des Marginelles. *Rev. Mag. Zool.* **3** (3): 164–271, pl. 7–8.
- ODHNER, N., 1923. Contribution to the marine Molluscan faunas of south and west Africa. *Gbgs. K. Vet. Vitt. Samh. Handl.* **26** (7): 1–39, 1 pl.
- REDFIELD, J. H., 1871. Catalogue of the known species, recent and fossil, of the family Marginellidae. *Amer. J. Conch.* **6**: 215–269.
- REEVE, L. A., 1864–65. *Conchologia iconica, or illustrations of the shells of Molluscos animals. Monograph of the genus Marginella*. Vol. **15**, 27 pl.
- TOMLIN, J. R. le B., 1917. A systematic list of the Marginellidae. *Proc. malac. Soc., Lond.* **12**: 242–306.
- WEINKAUFF, H. C., 1880. Catalog der arten der Gattung *Marginella* Lam. *Jb. Deutsch. Malak. Gesell.* **7**: 40–64.

OBSERVATIONS ON THE DIET OF *PHILINOPSIS* *CYANEA* (MARTENS) (CEPHALASPIDEA: AGLAJIDAE)

N. YONOW¹

(Accepted for publication, 22nd February, 1992)

Abstract: Gut contents of the opisthobranch *Philinopsis cyanea* from the Red Sea and Maldive Islands consisted of the opisthobranchs *Chelidonura sandrana*, *Bulla ampulla*, and a species of *Ringicula*.

Keywords: Opisthobranchia, Cephalaspidea, Aglajidae, *Philinopsis cyanea*, Red Sea, Maldives.

INTRODUCTION

Philinopsis cyanea (Martens, 1879) is a common Indo-West Pacific cephalaspidean opisthobranch which occurs also in the Red Sea. It grows to approximately 70 mm long. It is variable in colour, ranging from uniform purplish black with blue edging to light brown with cream to orange mottling on the shields and parapodia. It lives in the shallow sublittoral and intertidal zones, in and on sandy substrata, crawling on the surface in search of prey. Like the majority of Aglajidae whose diet has been studied or observed, *P. cyanea* is known to be a predator, and published reports indicate that it feeds on other opisthobranchs (Macnae 1962, Rudman 1972c, Gosliner 1987).

MATERIAL

Specimens of *P. cyanea* recently collected from the Red Sea and from the Maldive Islands have been examined during the course of systematic studies on the opisthobranch fauna of these regions (Yonow 1990; in prep.). Individuals from both of these widely separate localities were identical in colour, although colour variations have been reported by other authors (Macnae 1962, Rudman 1972c, Yonow 1990). They were very dark brown to black with blue-violet edging to the parapodia, continuous around the head, the posterior end of the head shield, and the posterior opening. The inner surfaces of the parapodia were deep purple. The posterior tip of the head shield was slightly protracted, and held up when the animal is crawling (Fig. 1). The fleshy parapodia did not meet dorsally and the two oval-rectangular shields were clearly visible. The anterior end of the head shield was indented medially. The shell is broadly oval with a small spire apposed to a recurved point, and weakly calcified (Fig. 2).

The Red Sea specimens, provided by T. Paulus, measured 11 × 3 mm and 5 × 3 mm preserved; unfortunately, only limited collecting data are available: May 1990, Marine Science Station, Aqaba, 3 m depth. Two Maldive specimens, both collected by the author on

¹ Marine Research Group, School of Biological Sciences, University College of Swansea, Swansea SA2 8PP, Wales, UK.

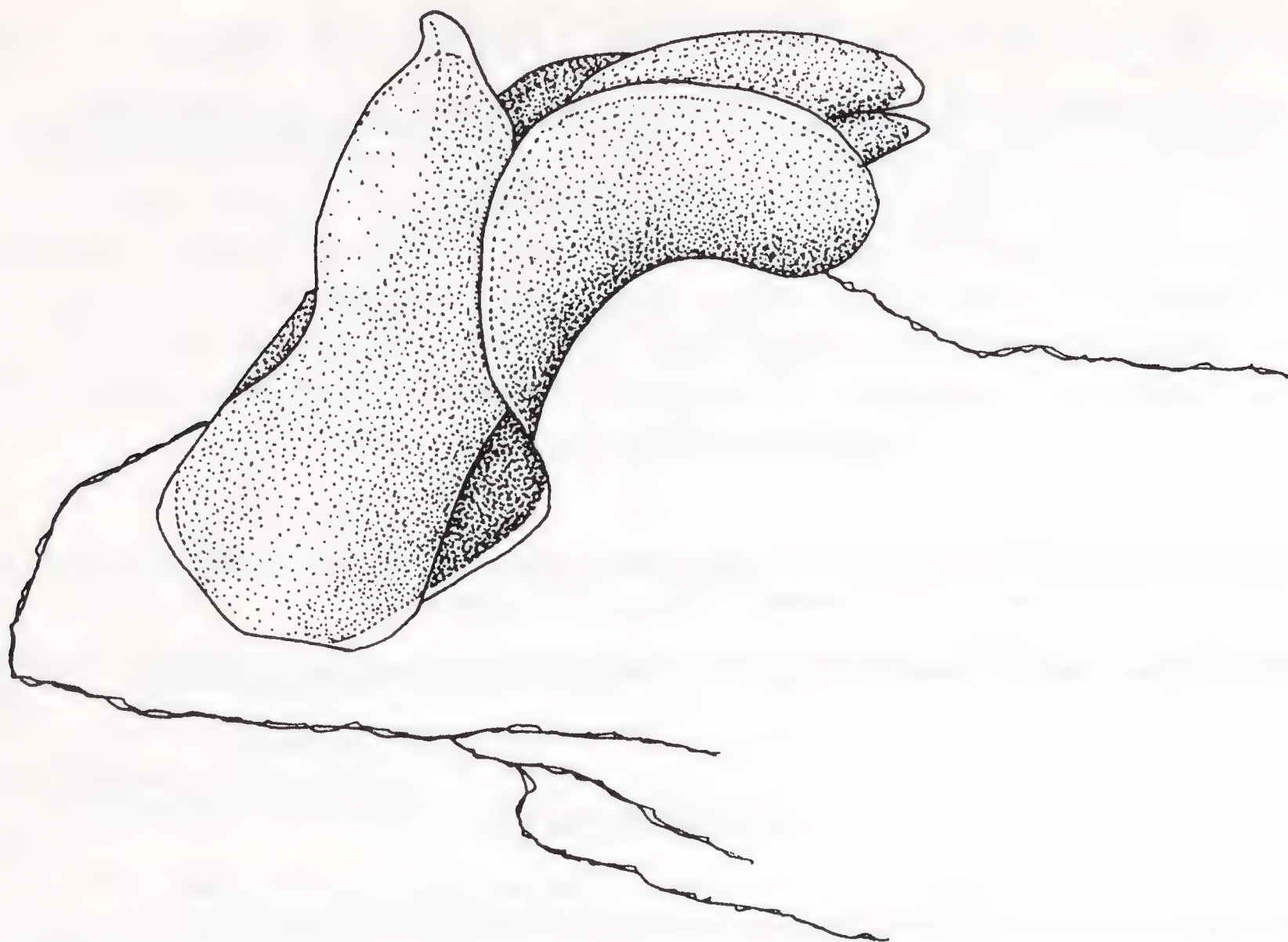


Fig. 1. *Philinopsis cyanea* crawling (drawn from photograph, Red Sea).

the evening of 12 January 1991 at Fulidhoo house reef, Felidhoo Atoll, measured 10×5 mm and 15×7 mm alive. These specimens were found crawling on rich silty/sandy substrate at 5 m depth. A third specimen from the Maldives was provided by R. Cattaneo-Vietti, collected from Gangehi, Ari Atoll; it measures 17×10 mm preserved.

OBSERVATIONS

Evidence of diet was obtained from three of the five specimens. The smaller of the two Fulidhoo specimens split during preservation, releasing three specimens of the cephalaspidean *Chelidonura sandrana* Rudman measuring 4×2 mm, 4×2 mm, and 3×2.5 mm. They had obviously only just been engulfed, as all specimens were intact. Two of the three specimens had everted the buccal bulb (Fig. 3). These specimens of *C. sandrana* were identical to others collected and preserved at the same time as the specimens of *Philinopsis cyanea* (Yonow, in prep.). *C. sandrana* was very abundant on the same silty/sand bottom, with a density of approximately two per m^2 . However, none of the live collected specimens had everted the buccal bulb during preservation in the same manner as those recovered from the gut of *Philinopsis cyanea*. The larger Fulidhoo specimen of *P. cyanea* was dissected, but nothing was found within the gut, as was also the case with the specimen from Gangehi.

Of the two Red Sea specimens of *P. cyanea*, the gut of one specimen was full of small shells, while the other contained just one shell, obviously different from those present in the first specimen. It was not recorded whether both specimens of *P. cyanea* were collected together or at different times. The gut contents of the two animals were clearly visible through the ventral body wall. The 11×3 mm (preserved) specimen contained a single opisthobranch shell (Fig. 4) belonging to the genus *Ringicula*. The shell was cleaned of animal tissue, and measured 3.5 mm in height and 2 mm at the widest part. The shell clearly belongs to a

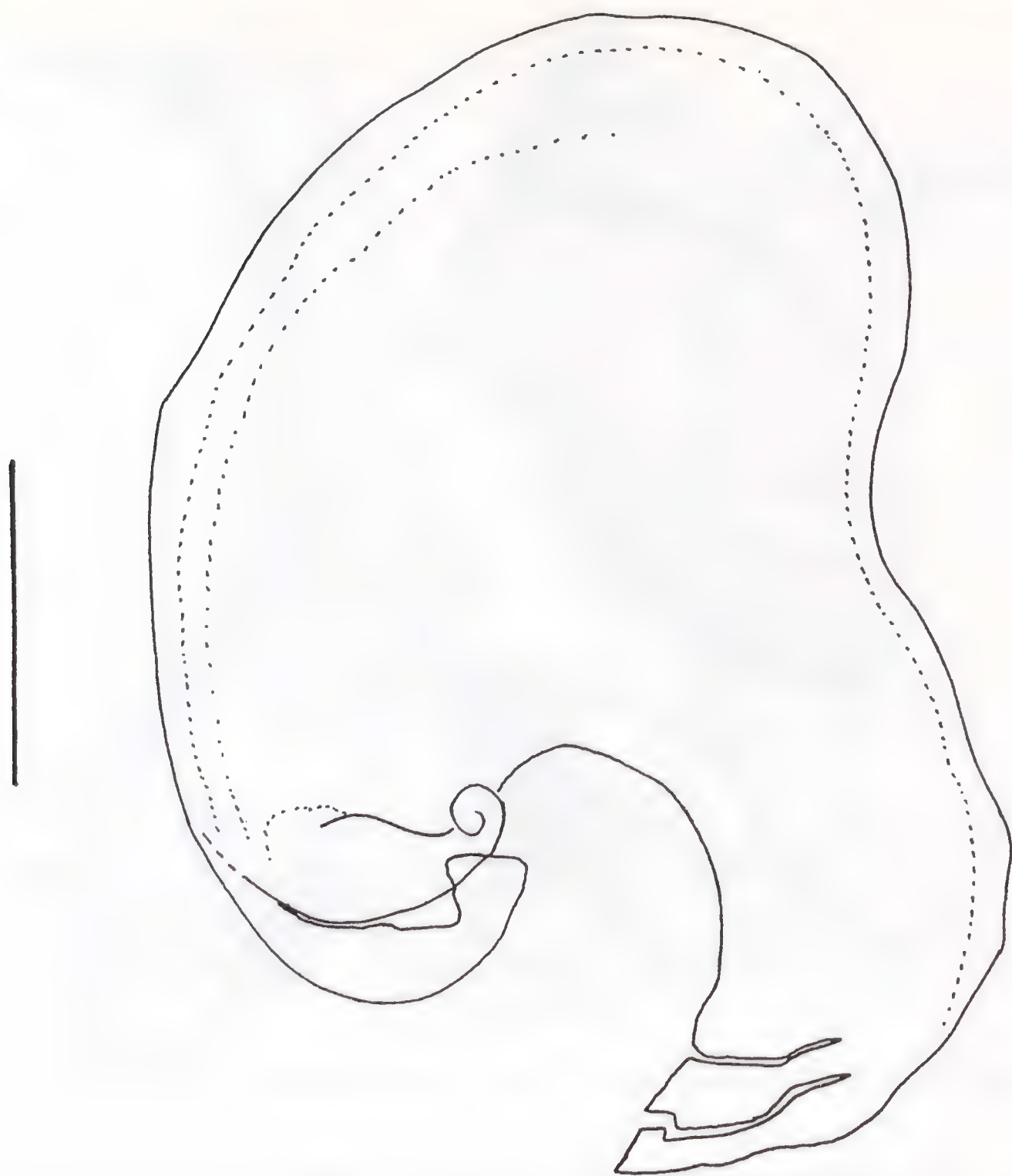


Fig. 2. Shell of *P. cyanea*, scale bar = 1 mm (camera lucida drawing of Maldivian specimen, 10 × 5 mm alive).

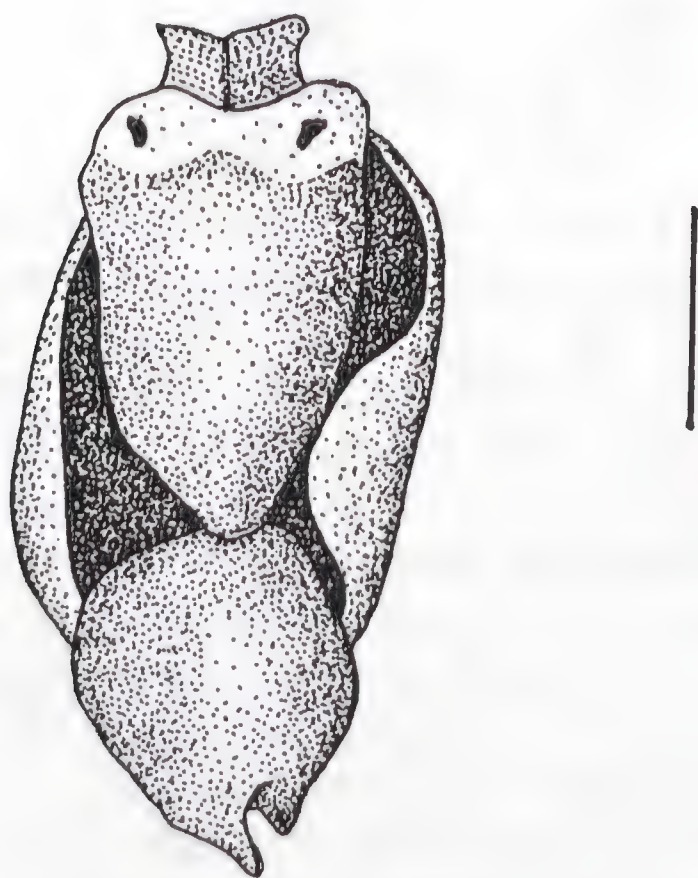


Fig. 3. *Chelidonura sandrana* collected from gut of *P. cyanea*, scale bar = 0.5 mm (camera lucida drawing, Maldives).

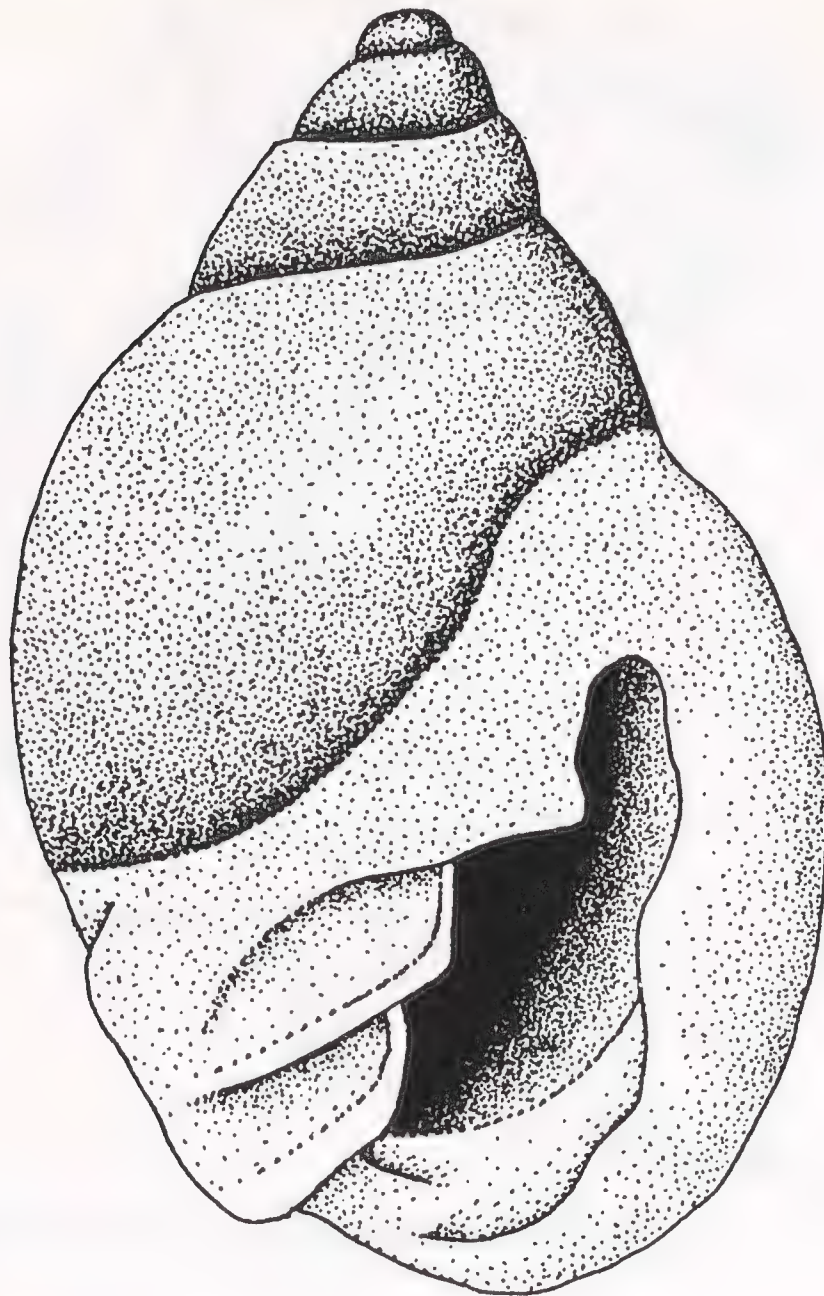


Fig. 4. *Ringicula* sp. collected from gut of *P. cyanea*, scale bar = 1 mm (camera lucida drawing, Red Sea).

mature specimen, with a thickened aperture and three distinctive teeth on the columella; it was translucent and white in colour. The 5×3 mm specimen of *P. cyanea* was bloated, containing 4 large and 8 small shells of *Bulla ampulla* (Linnaeus) (Figs. 5A-H). All but two of the shells were clean, devoid of animal tissue, and translucent, although the characteristic banding appears in the youngest shells in the series (Fig. 5H). The banding becomes very faint on the body whorl as the shell reaches 1.5 mm (Fig. 5B).

DISCUSSION

Predatory aglajids are well known. *Navanax inermis* (Cooper) is probably the best documented (Paine 1964), and is known to feed on shelled opisthobranchs. Rudman (1972a,b,c) made references to diet in his studies on *Melanochlamys* and *Philineopsis*. Species of *Melanochlamys* "suck in polychaete and nemertine worms", *Philineopsis cyanea* in Zanzibar feeds on *Bulla ampulla*, and *P. taronga* (Allan) feeds on *M. cylindrica* Cheeseman, *Philine auriformis* Suter, and *Haminaea zelandiae* (Gray in Dieffenbach). Macnae (1962) reported *P. cyanea* to feed exclusively on *Haminaea* and *Atys cylindricus* (Helbling) in South Africa. He observed that it took *P. cyanea* only a few hours to digest the animals and disgorge clean shells. Rudman (1972c) found his specimens in sea grass beds where *Bulla ampulla* was common. These formed the major item of diet of *P. cyanea*, with animals 30–70 mm long regurgitating 3–5 empty *Bulla* shells 5–15 mm height within 2–3 hours of capture. Gosliner (1987) reported *P. cyanea* feeding on *Haminaea natalensis* (Krauss); *Philineopsis capensis* (Bergh) feeding on *H. natalensis*, *H. alfredensis* Bartsch, and *Akera soluta* (Gmelin); and *Chelidonura hirundinina* (Quoy & Gaimard) upon flatworms (all in South Africa). Willan & Morton (1984) report

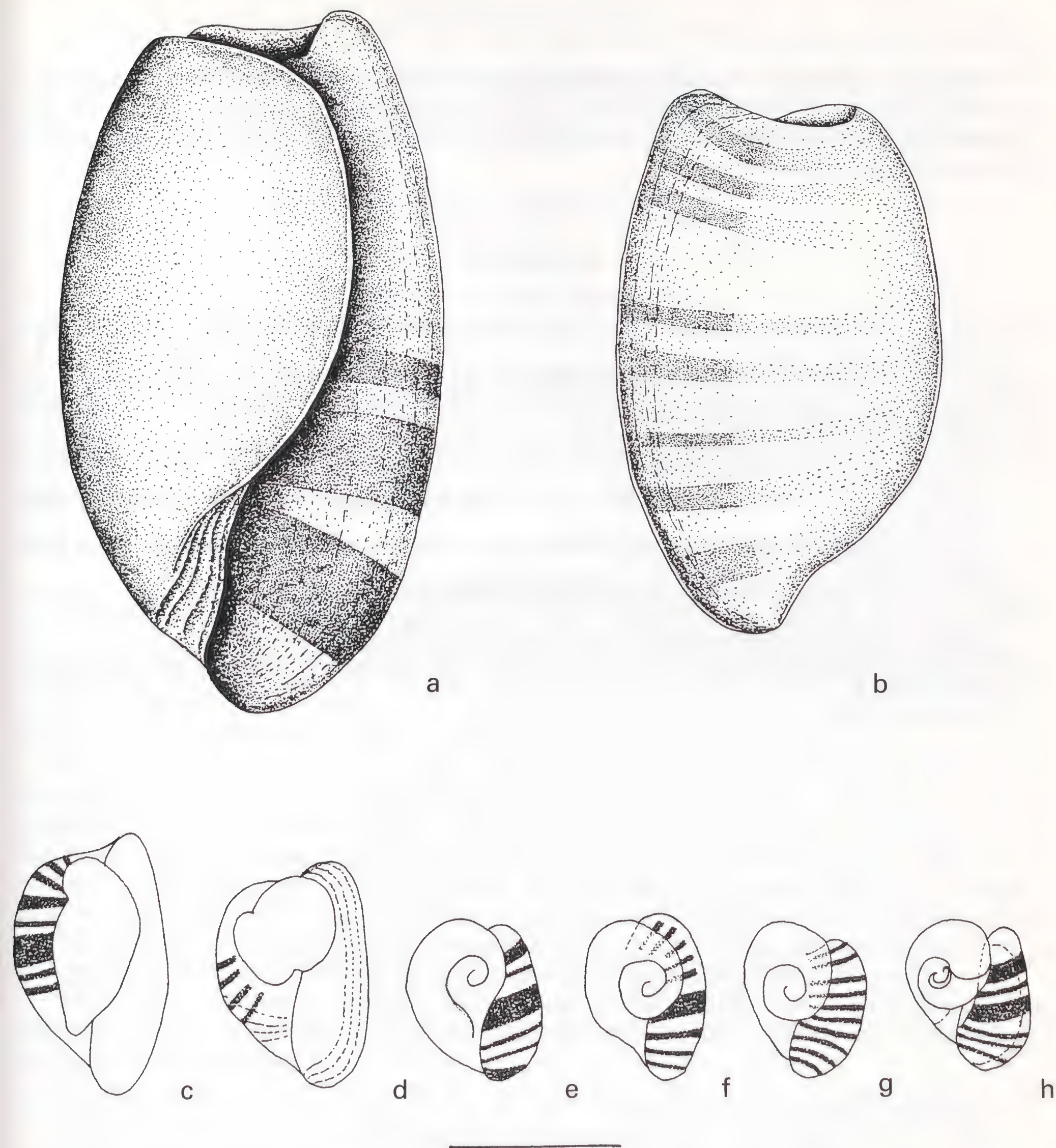


Fig. 5. *Bulla ampulla* found in gut of *P. cyanea*, scale bar = 0.5 mm (camera lucida drawings, Red Sea).

Melanochlamys cylindrica as feeding on whole nereid worms and *Philinopsis taronga* on *Haminaea zelandiae* in New Zealand.

Here, further evidence is provided for the somewhat opportunistic diet of *P. cyanea* from two previously unrecorded localities. Compared with animals for which size and number have been recorded (Rudman 1972c), these specimens of *Philinopsis* are feeding on proportionately larger prey, $1/5$ – $1/3$ body size. One may assume from the empty *Bulla* shells that 12 shells was an average 'feed'; however, as the *Chelidonura sandrana* had not yet been digested, there is no indication of how many would have been swallowed in one forage.

ACKNOWLEDGEMENTS

I would like to thank Dr. P. J. Hayward for his constructive discussions during this study. I am also grateful to Maldives Scuba Tours (U.K.) for financing the collecting trip, and to Mr. Thomas Paulus (Senckenburg Museum) and Dr. R. Cattaneo-Vietti (University of Genoa) for the additional specimens.

REFERENCES

- GOSLINER, T., 1987. *Nudibranchs of Southern Africa. A guide to opisthobranch molluscs of Southern Africa*. E. J. Brill, Leiden, The Netherlands. 136 pp.
- MACNAE, W., 1962. Tectibranch molluscs from Southern Africa. *Ann. Natal Mus.* **15** (16): 183–199.
- PAINE, R. T., 1964. Food recognition and predation on opisthobranchs by *Navanax inermis* (Gastropoda: Opisthobranchia). *The Veliger* **6** (1): 1–9.
- RUDMAN, W. B., 1972a. Structure and functioning of the gut in the Bullomorpha (Opisthobranchia). Part 4. Aglajidae. *J. nat. Hist.* **6** (4): 547–560.
- , 1972b. On *Melanochlamys* Cheeseman, 1881, a genus of the Aglajidae (Opisthobranchia, Gastropoda). *Pacific Science* **26** (1): 50–62.
- , 1972c. A comparative study of the genus *Philinopsis* Pease, 1860 (Aglajidae, Opisthobranchia). *Pacific Science* **26** (4): 381–400.
- WILLAN, R. & MORTON, J., 1984. *Marine Molluscs. Part 2. Opisthobranchia*. Leigh Marine Laboratory, New Zealand.
- YONOW, N., 1990. Red Sea Opisthobranchia 3. The Orders Sacaglossa, Cephalaspidea, and Nudibranchia: Doridacea (Mollusca, Opisthobranchia). *Fauna of Saudi Arabia* **11**: 286–299.
- , in prep. Opisthobranchs from the Maldivian Islands, with descriptions of six new species (Mollusca, Gastropoda).

REDESCRIPTION OF *SUBOESTOPHORA GASULLI* NOV. COMB. FOR *OESTOPHORA (GASULLIA)* *GASULLI* (GASTROPODA: PULMONATA)

B. MUÑOZ¹ AND C. PAREJO¹

(Accepted for publication, 18th April, 1992)

Abstract: The description of the genital system of *Oestophora (Gasullia) gasulli* Ortiz de Zárate & Ortiz de Zárate, 1961, leads us to assign this species to the genus *Suboestophora* Ortiz de Zárate López, 1962. This species, which is characterized by two dart sacs and one flagellum, has been erroneously attributed to the genus *Oestophora* Hesse, 1907. On the basis of the redescription of the taxonomic characters, the systematic position of the subgenus *Suboestophora* Ortiz de Zárate López, 1962 is discussed and elevated to generic rank.

Keywords: *Suboestophora*, *Oestophora*, Spain, systematics

INTRODUCTION

During a survey of the terrestrial malacofauna in Western Spain (regions of Cáceres, Badajoz and Huelva), one of the species was assigned to *Oestophora (Gasullia) gasulli* Ortiz de Zárate & Ortiz de Zárate, 1961, on the basis of its shell characters and radula, although the genital system was found to differ in some features from the original description.

Ortiz de Zárate & Ortiz de Zárate (1961: 179) indicated that the holotype has been deposited in the Museo Nacional de Ciencias Naturales in Madrid, while the paratypes remained in their private collection. Unfortunately, the holotype in the collection of the Museo is lost. Furthermore, only the shells of three paratypes from the private collection of A. Ortiz de Zárate, were available: one from Valverde del Camino (Huelva), the type-locality, another from Ermitas (Córdoba) (collected by L. Gasull and cited in the origin description), and a third paratype lacking locality data but probably collected in the vicinity of Almería according to A. Ortiz de Zárate Rocandio (personal communication).

The study of specimens recently collected at the type-locality and from new localities (regions of Huelva and Badajoz) forms the basis of a redescription of this species and leads us to assign it to a new genus.

MATERIAL EXAMINED (Fig. 1)

—Valverde del Camino (type-locality): Ermita Virgen de España (Huelva); amongst rock-rose (*Cistus ladanifer*) and on alluvium; U.T.M. grid reference: 29SPB9063, 100 m a.s.l., 29.6.1988; 3 + 1 juv. specimen; B. Muñoz and C. Parejo leg.

—Llera: Matachel river (Badajoz); amongst Spanish broom (*Retama sphaerocarpa*) on slates; U.T.M. 29SQC5565, 360 m a.s.l., 15.12.1988; 6+3 juv. specimens; B. Muñoz and C. Parejo leg.

—Maguilla: Matachel river (Badajoz); in evergreen-oak grove (*Quercus rotundifolia*) on slates; U.T.M. 30STH5354, 490 m a.s.l., 19.4.1989; 1+3 juv. specimens; L. Agüera and C. Parejo leg.

¹ Dept. Biología Animal I (Zoología). Facultad de Biología. Universidad Complutense, 28040 Madrid. Spain.

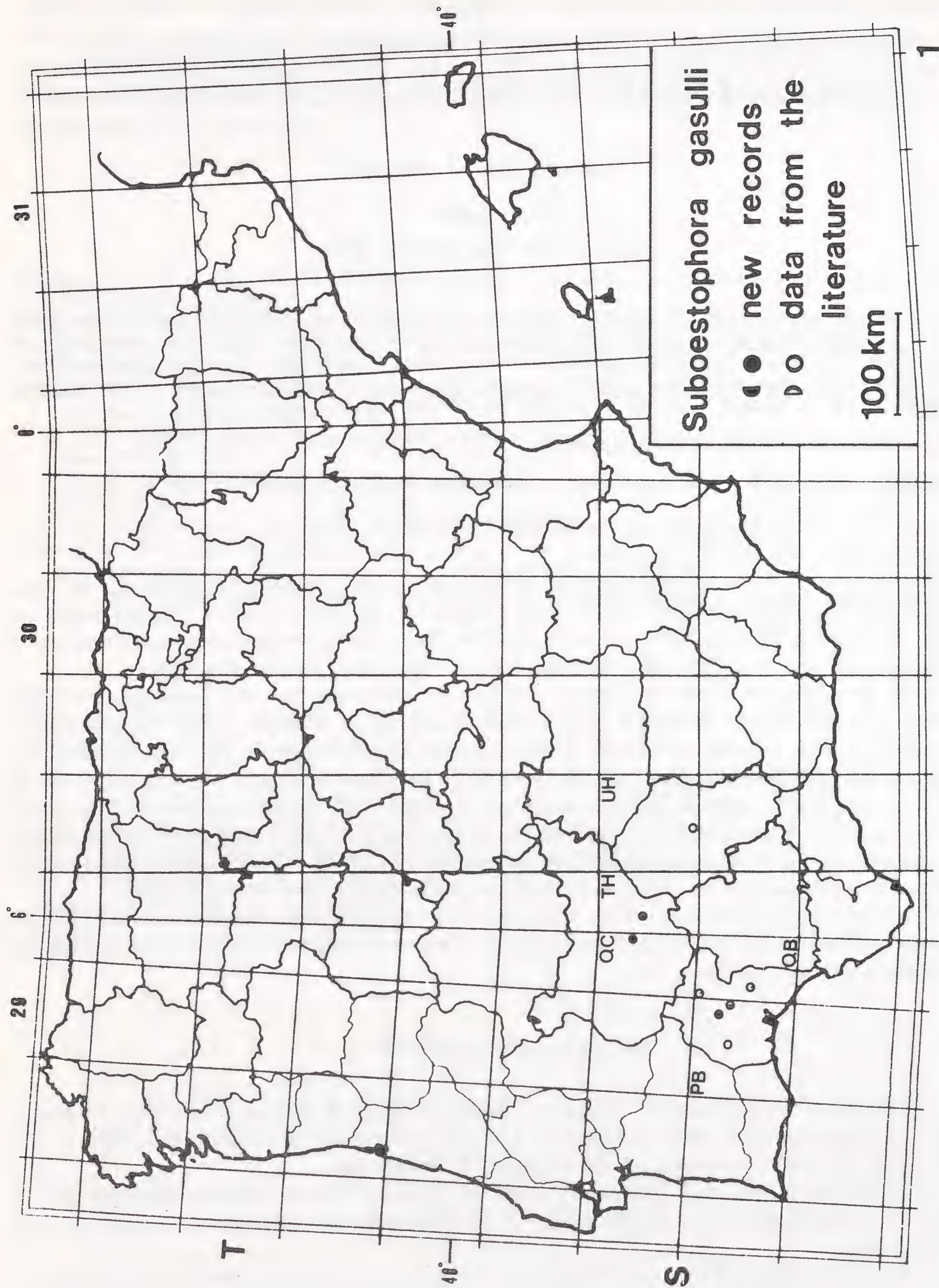


Fig. 1. Distribution of *Suboestophora gasulli*.

— El Cerro de Andévalo: Casa Huerta del Sombrero (Huelva); in evergreen-oak grove (*Quercus rotundifolia*) on slates; U.T.M. 29SPB8077, 240 m a.s.l., 14.12.1988; 4+2 juv. specimens; L. Agüera, B. Muñoz and C. Parejo leg.

— El Cerro de Andévalo: ribera Chica (Huelva); amongst wild olives (*Olea europaea*) on rhyolite; U.T.M. 29SPB8179, 200 m a.s.l., 14.12.1988; 2+5 juv. specimens; L. Agüera, B. Muñoz and C. Parejo leg.

— Valverde del Camino (Huelva); U.T.M. 29SPB96, 100 m a.s.l., 5.12.1950; A. Ortiz de Zárate Rocandio leg., 1 shell, paratype Ortiz de Zárate collection.

— Córdoba: Ermitas (Córdoba); U.T.M. 30SUH4102, 320 m a.s.l., 25.5.1948; L. Gasull leg., 1 shell, paratype Ortiz de Zárate collection.

— Almería?; 1 shell, Ortiz de Zárate collection.

DESCRIPTION

Shell (Fig. 2).

Medium-sized shell, depressed, convex, with low conical spire, of $4\frac{1}{2}$ to 5 regularly expanding whorls with deep sutures. The last whorl is a little wider than the previous one and well-rounded on the whole periphery. Umbilicus width approximately $\frac{1}{4}$ of the maximum diameter, deep, and with all the internal structures visible. Mouth nearly circular, with a simple, unthickened, peristome.

Light brown colour, being slightly paler on its lower surface. Upper surface with fine, weak and irregular transverse ribbing. Lower surface, virtually smooth except for some slight ribbing.

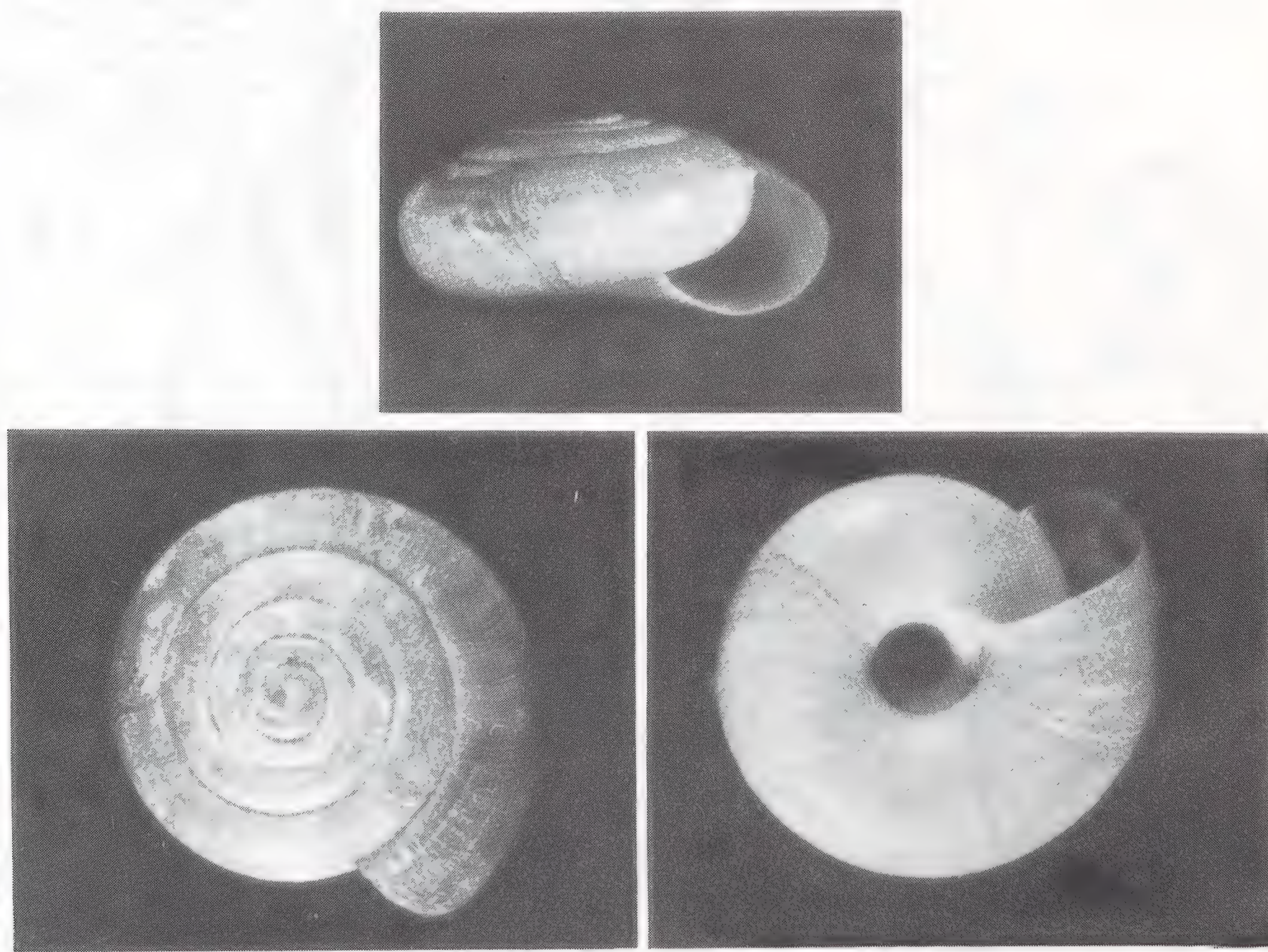


Fig. 2. Shell of *Suboestophora gasulli*. Actual width 9.7 mm.

Dimensions: Diameter: 8.9–10.7 mm (average: 9.6 mm); height: 4.3–4.8 mm (average: 4.55 mm) mouth; 3.6–4.5 mm (average: 3.9 mm); umbilicus width: 2.4–2.9 mm (average: 2.5 mm).

Genital system (Figs. 3 to 6).

Atrium approximately as long as the vagina.

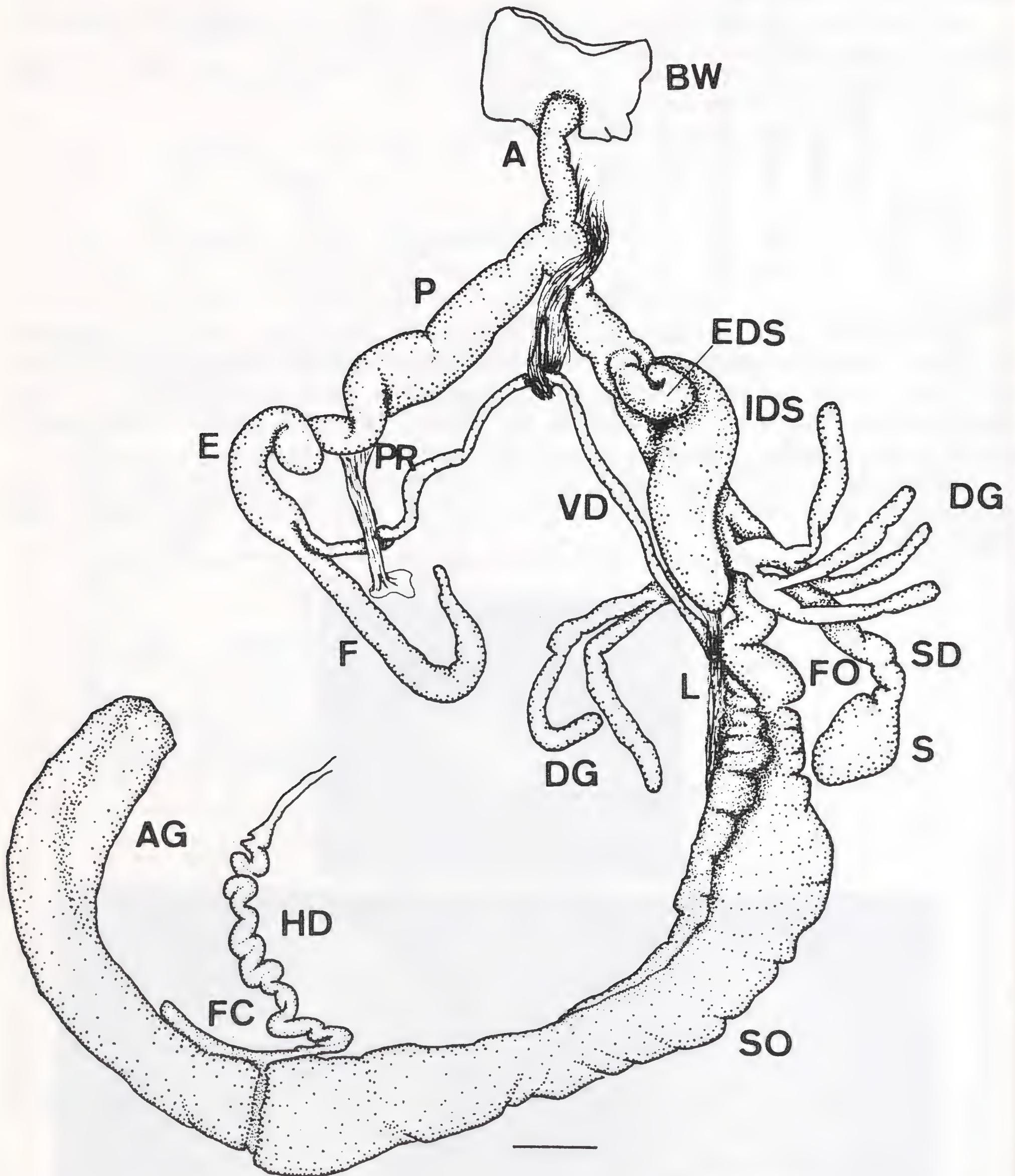


Fig. 3. *Suboestophora gasulli*: genitalia (except gonad) of a specimen collected in El Cerro de Andévalo (Huelva). Scale 1 mm.

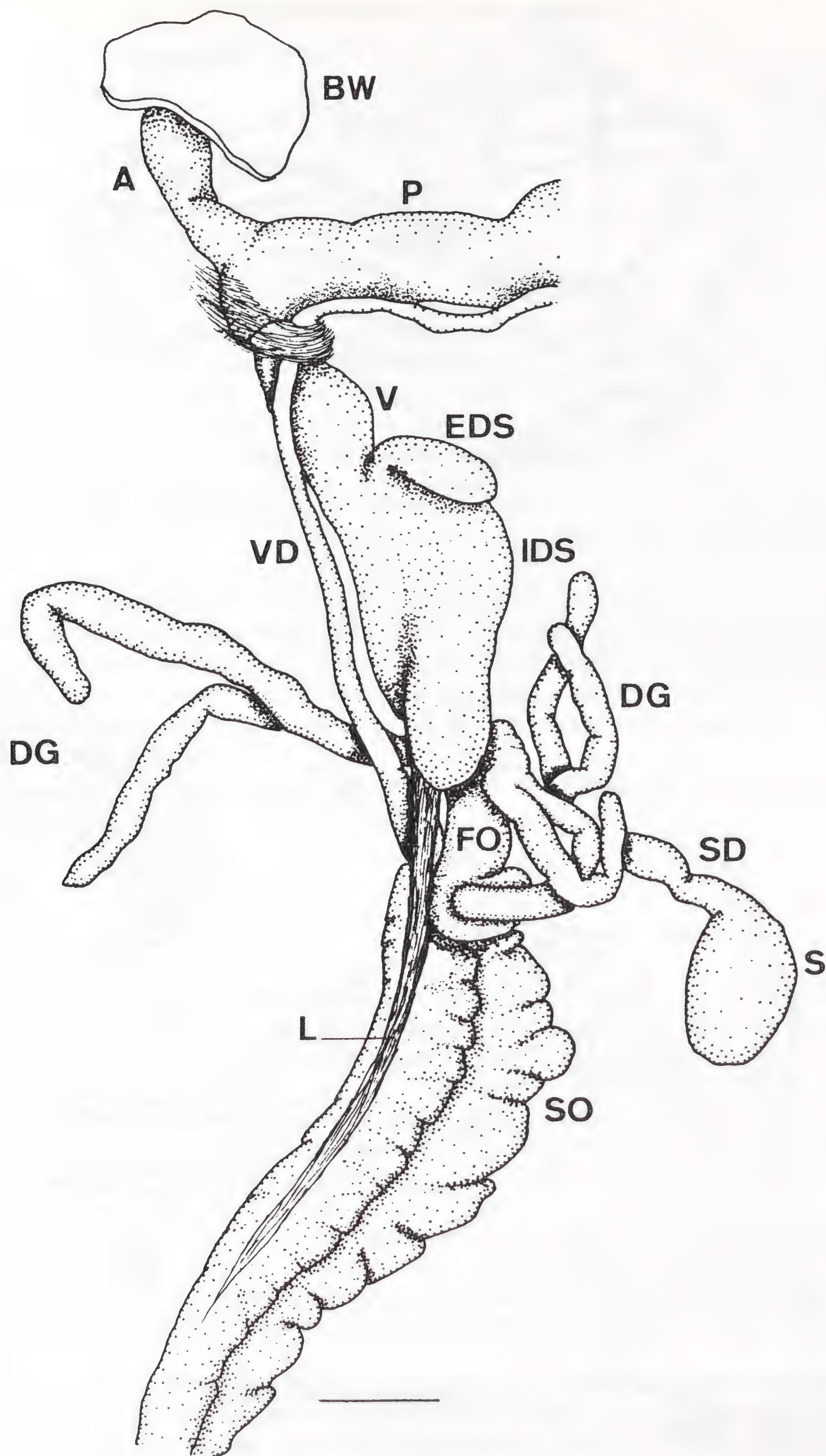


Fig. 4. *Suboestophora gasulli*, portion of the genitalia in same specimen as in Figure 3. Note the muscular-connective ligament (L). Scale 1 mm.

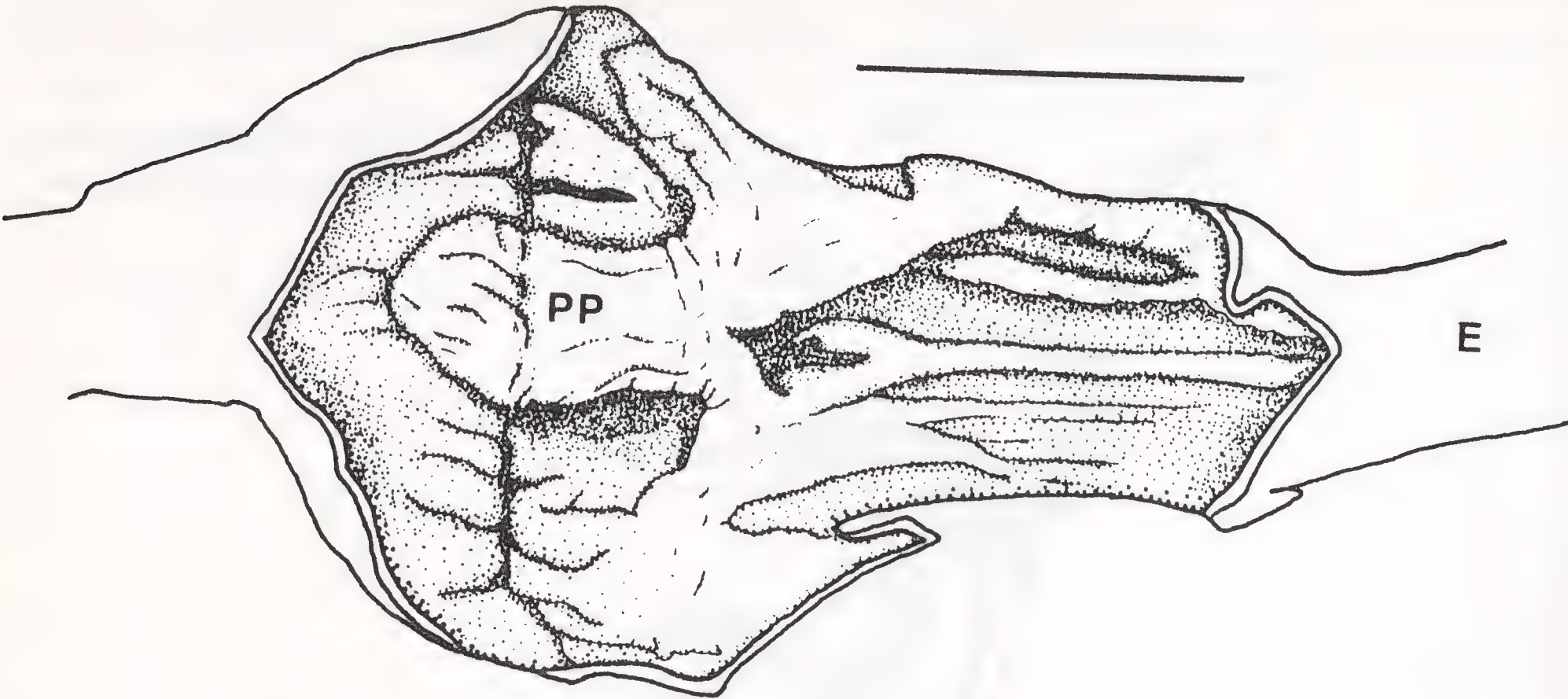


Fig. 5. *Suboestophora gasulli*, inner structure of the penial wall and penial papilla (PP) in a specimen collected in El Cerro de Andévalo (Huelva). Scale 1 mm.

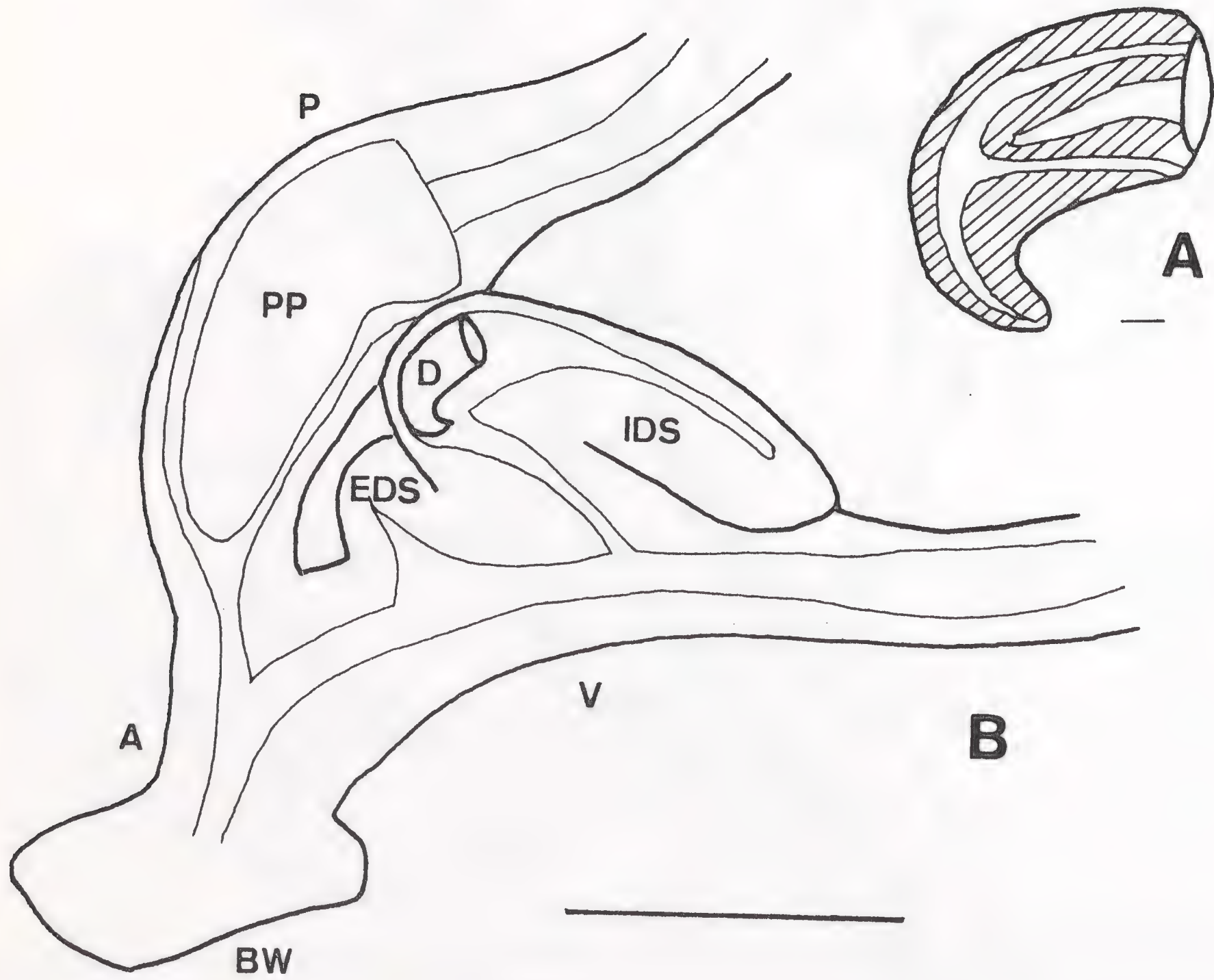


Fig. 6. *Suboestophora gasulli*, A: dart. Scale 0.1 mm.; B: diagram of the position of the dart within the internal dart sac (IDS). Scale 1 mm. Specimen collected in Llera (Badajoz).

Abbreviations used in the figures

A — Atrium	F — Flagellum	PR — Penial retractor
AG — Albumen gland	FC — Fertilization chamber	S — Spermatheca
BW — Body wall	FO — Free oviduct	SD — Spermatheca duct
D — Dart	HD — Hermaphroditic duct	SO — Spermoviduct
DG — Digitiform glands	IDS — Internal dart sac	V — Vagina
DS — Dart sac	L — Ligament	VD — Vas deferens
E — Epiphallus	P — Penis	
EDS — External dart sac	PP — Penial papilla	

Penis spindle-shaped, entirely surrounded by a strong muscular sheath, distally wider and more muscular. Penis provided with a large cylindrical penial papilla with a cup-shaped apex. Inner wall of the penis with irregular ribs up to the papilla, followed by three large folds, prolonged by the epiphallus (Fig. 5). Retractor muscle of the penis short and strong. Epiphallus elbowed, longer and a little narrower than the penis. Flagellum as long as the epiphallus, narrower and spindle-shaped in its distal part. The right ommatophore retractor passes between penis and vagina.

Vagina wide and strong. On one side there are two dart sacs, the external sac being much smaller than the internal one which has in its proximal part a small curved, hook-shaped dart (Figs. 3, 4, 6); the internal sac and vaginal junction covers 2/3 parts to the length of the vagina. From the base of the free portion arises a muscular-connective ligament, linking the dart sac to the spermoviduct, just before the albumen gland (Fig. 4). At the distal part of the vagina, arises the two branches of the digitiform glands, each with 2–4 digitations. At the same level originates the short spermathecal duct, as wide as the flagellum, and without diverticulum; spermatheca oval.

Spermoviduct wide and long. Hermaphroditic duct long and convoluted. Albumen gland long and slender.

DISCUSSION

There is a strong similarity between the recently collected shells, the shells of the Ortiz de Zárate's collection and the original description of Ortiz de Zárate & Ortiz de Zárate (1961), although Ortiz de Zárate (1962) indicated that the shells of the specimens from Ermitas (Córdoba) show small differences to those collected in the region of Huelva. The latter author pointed out that they may belong to two different species, but he admitted the other anatomical and conchological similarities between the specimens of both localities. In the shell from Ermitas (Córdoba), available to us, we also observed only small variations compared to all the other specimens.

According to Ortiz de Zárate & Ortiz de Zárate (1961), the radula consists of 115 transverse rows, with a central tricuspid tooth, 12 lateral bicuspid teeth and 15 marginal teeth (in which the main cuspid is unfolded). The radula of the studied material show small variations: 106–119 transversal rows, with 11–13 lateral bicuspid teeth and 14–17 marginal teeth.

The main difference to the original anatomical description concerns the genital system, i.e. the presence of two dart sacs and one flagellum. These new taxonomic criteria lead us to separate this species from the genus *Oestophora* Hesse, 1907, which is characterized by a simple thick dart sac and by the absence of flagellum. Nevertheless, because the presence of

a flagellum is observed in some species, Ortiz de Zárate & Ortiz de Zárate (1961) divided the genus *Oestophora* into three subgenera according to the following characters:

– *Oestophora* s.s.: with the shell and anatomical characters attributed to the genus by Hesse (1918), i.e. large dart sac; 2–3 simple multifid glands (= digitiform), large and very sinuated; flagellum absent; shells with regular ribs; peristome with internal callus.

– *Suboestophora*: with a short flagellum, multifid glands, shell ribbing, and inner lip of the peristome similar to the former subgenus.

– *Gasullia*: with large flagellum; two branches of the multifid glands, shorter than in the previous subgenera, each branch with 2–3 digitations; shells with irregular ribbing; peristome without inner lip.

Prieto (1986) indicated that two species, which he did not name, of the subgenus *Suboestophora* have two dart sacs (and not one as represented by Ortiz de Zárate, 1962); the small external sac, bearing the dart, close to the larger internal one, is difficult to see. Consequently, Prieto (1986) suggested that the subgenus *Suboestophora* may be an independent genus. He proposed also that *Oestophora* (*Gasullia*) *gasulli* belongs to this new genus, because it does not show significant differences. We confirm that suggestion with the specimens analysed in this paper.

On the basis of the redescription of the anatomical features, the subgenus *Suboestophora* is raised to generic rank, with *Suboestophora gasulli* (Ortíz de Zárate & Ortíz de Zárate, 1961) as its type-species.

The position of this genus among the higher taxa, is now under question. It should belong to the subfamily Helicodontinae according to Hesse (1918). Gittenberger (1968) divided this subfamily in two groups, without giving them taxonomic rank. Schileyko (1979) raised this taxon to the category of family. Nordsieck (1987) considered it a subfamily of the Hygromiidae, but Hausdorf (1988) criticized this position because of the lack of appropriate data of the species involved in that group.

Because of the anatomical and shell characters, the genus *Suboestophora* stays nearest to the genera *Trissexodon*, *Mastigophallus* and *Oestophorella*. We agree with the opinion of Giusti & Manganelli (1988) that all these genera have to be included into a heterogeneous group, i.e. the “helicodontids”, close to the Family Hygromiidae. Obviously, a detailed anatomical study of the whole group is needed before dealing with a new taxonomical position.

The diagnosis of the genus *Suboestophora* is:

Shell depressed with umbilicus; mouth nearly circular; peristome simple or with a thickened lip.

Penis with penial sheath; large internal penial papilla; flagellum; two dart sacs, a small external sac, adhering to a larger internal sac, nearly totally joined to the vagina. Ligament linking the base of the free portion of the inner dart sac to the spermoviduct. Small dart, more or less curved, present in any of the two sacs. Digitiform glands in two branches each with 2–4 digitations.

DISTRIBUTION (Fig. 1)

The occurrences of *Suboestophora gasulli* in the South-west of Spain are: Valverde del Camino (type-locality) (U.T.M. 29SPB9063), Puebla de Guzman (U.T.M. 29SPB5464), La Palma del Condado, (U.T.M. 29SQB1740), and Santa Ana la Real (U.T.M. 29SQB0093), in the region of Huelva, and Ermitas (U.T.M. 30SUH4102), in the region of Córdoba, probably also in the region of Almeria (Ortíz de Zárate and Ortíz de Zárate (1961), Ortíz de Zárate (1962) and Gasull (1985)).

Four new locations can be cited: two places near to El Cerro de Andévalo, (U.T.M.

29SPB8077 and 29SPB8179) region of Huelva, and in Llera (U.T.M. 29SQC5565) and Maguilla (U.T.M. 30STH5354) (South of the region of Badajoz), which appears to be the northern distributional limit. The geographical distribution of *Suboestophora gasulli* covers the Sierra de Aracena (both sides), the Sierra Morena, as well as probably the region of Almería.

ACKNOWLEDGEMENTS

We thank Mrs. C. Parejo for translating the text into English. Dr. C. Emig, of the Station Marine d'Endoume (Marseille) and Dr. M. T. Aparicio, malacologist of the Museo Nacional de Ciencias Naturales (Madrid), critically read an earlier version. Mr. A. Ortiz de Zárate Rocandio kindly allowed us to study his collection.

REFERENCES

- GASULL, L., 1985. Fauna malacológica continental de la provincia de Huelva (España). *Misc. Zool.* **9**: 127–143.
- GITTENBERGER, E., 1968. Zur Systematik der in die Gattung *Trissexodon* Pilsbry (Helicidae, Helicodontinae) gerechneten Arten. *Zool. Meded.* **43**: 165–172.
- GIUSTI, F. & MANGANELLI, G., 1988. Notula Malacologicae, XL. *Montserratina* Ortiz de Zárate López, 1946 (Pulmonata, Hygromiidae): a redescription. *Iberus*, **8**: 89–100.
- HAUSDORF, B., 1988. Zur Kenntnis der systematischen Beziehungen einiger Taxa der Helicellinae Ihering 1909 (Gastropoda; Hygromiidae). *Arch. Molluskenk.* **119** (1/3): 9–37.
- HESSE, P., 1918. Die Subfamilie Helicodontinae. *Nachrbl. dtsch. malak. Ges.* **50**: 99–110.
- NORDSIECK, H., 1987. Revision des System der Helicoidea (Gastropoda: Stylommatophora). *Arch. Molluskenk.* **118** (1/3): 9–50.
- ORTIZ DE ZARATE LOPEZ, A., 1962. Observaciones anatómicas y posición sistemática de varios helícidos españoles. V. Género *Oestophora* Hesse, 1907. *Bol. R. Soc. esp. Hist. nat. (Biol.)* **60**: 81–104.
- ORTIZ DE ZARATE ROCANDIO, A. & ORTIZ DE ZARATE LOPEZ, A., 1961. Moluscos terrestres recogidos en la provincia de Huelva. *Bol. R. Soc. esp. Hist. nat. (Biol.)* **59**: 169–190.
- PRIETO, C. E., 1986. *Estudio sistemático y biogeográfico de los Helicidae sensu Zilch, 1959–60 (Gastropoda: Pulmonata: Stylommatophora) del País Vasco y regiones adyacentes*. Tesis doctoral, (unpublished), Universidad del País Vasco, 393 pp.
- SCHILEYKO, A. A., 1979. The system of the order *Geophila* (= Helicida) (Gastropoda; Pulmonata) [in Russian]. *Acad. Sci. USSR Proc. Zool. Inst.* **80**: 44–90.

COCHLICOPA NITENS (GALLENSTEIN) IN THE BRITISH LATE-GLACIAL AND HOLOCENE

R. C. PREECE¹

(Accepted for publication, 16th May, 1992)

Abstract: A detailed biometric study of the *Cochlicopa* from Late-glacial and Post-glacial deposits at Holywell Coombe, Folkestone has demonstrated the presence of three species – *Cochlicopa lubrica*, *C. lubricella* and *C. nitens*. The last, which can be readily distinguished from the others on account of its much broader (2.83–3.16 mm), darker-coloured shell, was only present in marsh sediments that accumulated under interstadial conditions at the beginning of the Late-glacial period (12–13,000 BP). This constitutes a new record from the British Late-glacial. Re-examination of fossil *Cochlicopa* from other sites has shown that *C. nitens* was also present in Late-glacial deposits of similar age in Northamptonshire and from early Post-glacial tufas in Lincolnshire and North Wales. It has also been recognized from several Late Pleistocene interglacial sites in eastern England.

Keywords: Cochlicopidae, Holywell Coombe, Folkestone, Kent, Late-glacial, Holocene

INTRODUCTION

During a detailed study of the molluscan successions of calcareous valley sediments near Folkestone, Kent, it became obvious that three species of *Cochlicopa* were represented (Fig. 1). This paper presents biometric and stratigraphical data demonstrating that in the early part of the Late-glacial (12–13,000 BP), *Cochlicopa nitens* was present, together with *C. lubrica* and *C. lubricella*, in marsh communities that also supported arctic-alpine species such as *Vertigo genesii* and *Catinella arenaria*. This is a particularly noteworthy discovery since *C. nitens* is today a scarce species known from only a few scattered localities in central and eastern Europe.

THE SITE AND ITS STRATIGRAPHY

The site (National Grid reference TR 2200379) lies on the Gault Clay at the mouth of an escarpment valley, Holywell Coombe, immediately west of Sugarloaf Hill. Previous work (Kerney, Preece & Turner 1980) had demonstrated that the floor of the valley was covered with a thick sequence of colluvial sediments. The stratigraphy was essentially tripartite comprising (1) a basal sequence of chalk muds and gravels derived from the surrounding slopes principally by solifluction during the Late-glacial (2) early to mid Post-glacial tufa and (3) hill-wash resulting from forest clearance since the Neolithic.

New work on these important sediments was initiated in 1987 in response to the proposal to construct the Channel Tunnel. A detailed borehole survey was undertaken to pin-point critical areas within the valley that would repay study in open section. Deep trenches were subsequently cut in these locations to allow detailed systematic sampling and careful logging of the stratigraphy.

¹ Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ

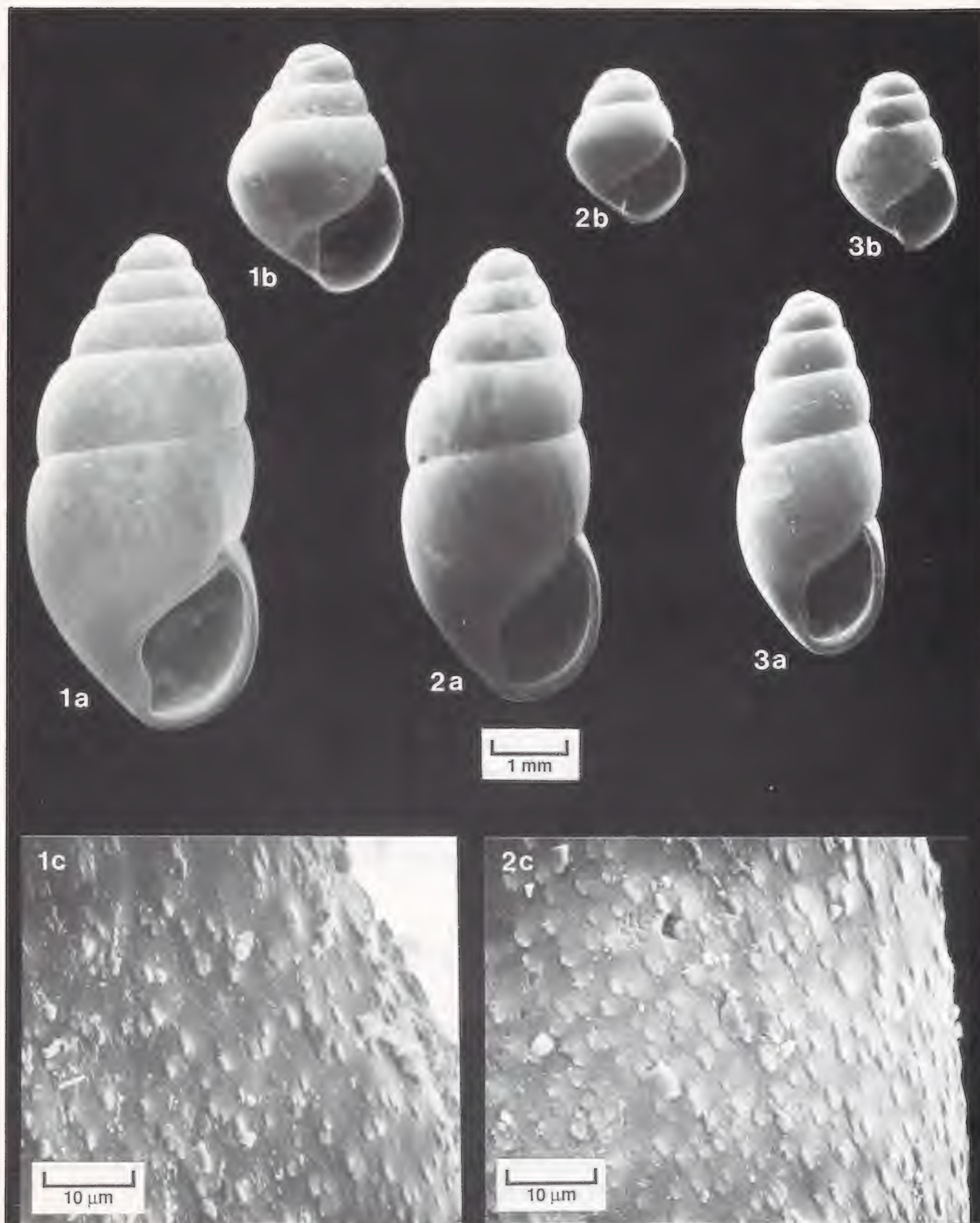


Fig. 1. Scanning electron micrographs of Late-glacial *Cochlicopa* from Holywell Coombe, Folkestone (Trench HV 420–430 cm).

1. *Cochlicopa nitens* (Gallenstein). (a) adult shell (b) juvenile (c) close-up of the minute rasp-like denticles on the columellar lip.

2. *Cochlicopa lubrica* (Müller). (a) adult shell (b) juvenile (c) close-up of the minute rasp-like denticles on the columellar lip (note slightly greater density than in *C. nitens* (1c)).

3. *Cochlicopa lubricella* (Porro). (a) adult shell (b) juvenile.

In the initial study (Kerney *et al.* 1980), the basal Late-glacial sediments exposed in the trial pits were all ascribable to the Younger Dryas (Loch Lomond Stadial). The new work has demonstrated that, in other parts of the valley, the Late-glacial record extends back to at least 13,000 BP. The Late-glacial record at Holywell Coombe has now been shown to comprise (1) basal marsh sediments that accumulated under temperate interstadial conditions between 11,800–13,000 BP (2) brief episode of erosion from the slopes of Sugarloaf Hill between ~11,500 and 11,800 BP (3) period of stability reflected by the widespread occurrence of a fossil soil, the so called 'Allerød soil' (11–11,500 BP) (4) climatic deterioration and re-activation of slope-processes during the Younger Dryas (10–11,000 BP). Although the full details of this work will appear elsewhere, I have already presented a preliminary discussion of the dating evidence (Preece 1991) and an outline account of the environmental history (Preece 1992).

BIOMETRIC DATA

Several authors have shown that the two common species of European *Cochlicopa*, *C. lubrica* (Müller) and *C. lubricella* (Porro), can be readily separated using simple biometric data. Thus, although there may be some overlap in both lengths and breadths, *C. lubricella* can generally be distinguished from *C. lubrica* by its smaller, more cylindrical shell, its flatter whorls and more obtuse apex. There are also anatomical differences, particularly with respect to the distal genitalia (Quick 1954) but these may not always be as clear-cut as the differences in shell morphology (Waldén 1955).

Early accounts have regarded *nitens* as either a large form or sub-species of *C. lubrica* (e.g. Ehrmann 1933, Zilch & Jaekel 1962) but its specific distinctness is confirmed not only by detailed studies of the shell shape and size (Nilsson 1956) but also by distinctive features of the genital anatomy (Hudec 1960). There are also important ecological differences. *C. nitens* has more specialized habitat preferences than either *C. lubrica* or *C. lubricella* and only occurs in calcareous marshes or very damp woodland.

Most authors agree that the differences in shell breadth provide one of the most useful characters separating the three species. Accordingly, measurements were made of the lengths and breadths of all the *Cochlicopa* in a series of stratified samples from Holywell Coombe, Folkestone. The samples range in age from the early part of the Late-glacial up to the late Post-glacial, a span of some 13,000 years. A map showing the precise locations of the individual trenches, from which the samples came, is given by Preece (1991, Fig. 1). The shells were measured optically using a Wild microscope with a graticule eye-piece. Only adult shells were measured. In addition to complete shells, breadth measurements have also been taken from shells that lack apices, since much of the fossil material was fragmentary. This accounts for the discrepancy between the number of measurements for breadth and height (Table 1). The measurements are accurate to ± 0.08 mm. (Table 1, Figs 2 and 3).

These measurements reveal a clear trimodal distribution consistent with the existence of three separate species which have been assigned to *Cochlicopa lubricella*, *C. lubrica* and *C. nitens* (Fig. 2, Table 1). Half-grown shells can also be identified with reasonable confidence (Fig. 1), although this is not always possible. The measurements for the first two species are very similar to comparable data published from the British Isles (Quick 1954), Denmark (Mandahl-Barth 1950, Quick 1954), Sweden (Waldén 1955) and central Europe (Nilsson 1956, Hudec 1960). The measurements of the *C. nitens* from Folkestone are also very similar to published data obtained from modern populations from central Europe (Table 2). According to Nilsson (1956) the size of the shell of *C. nitens* varies between extremes in height of 6.0 and 8.5 mm and 2.7 and 3.5 mm in breadth.

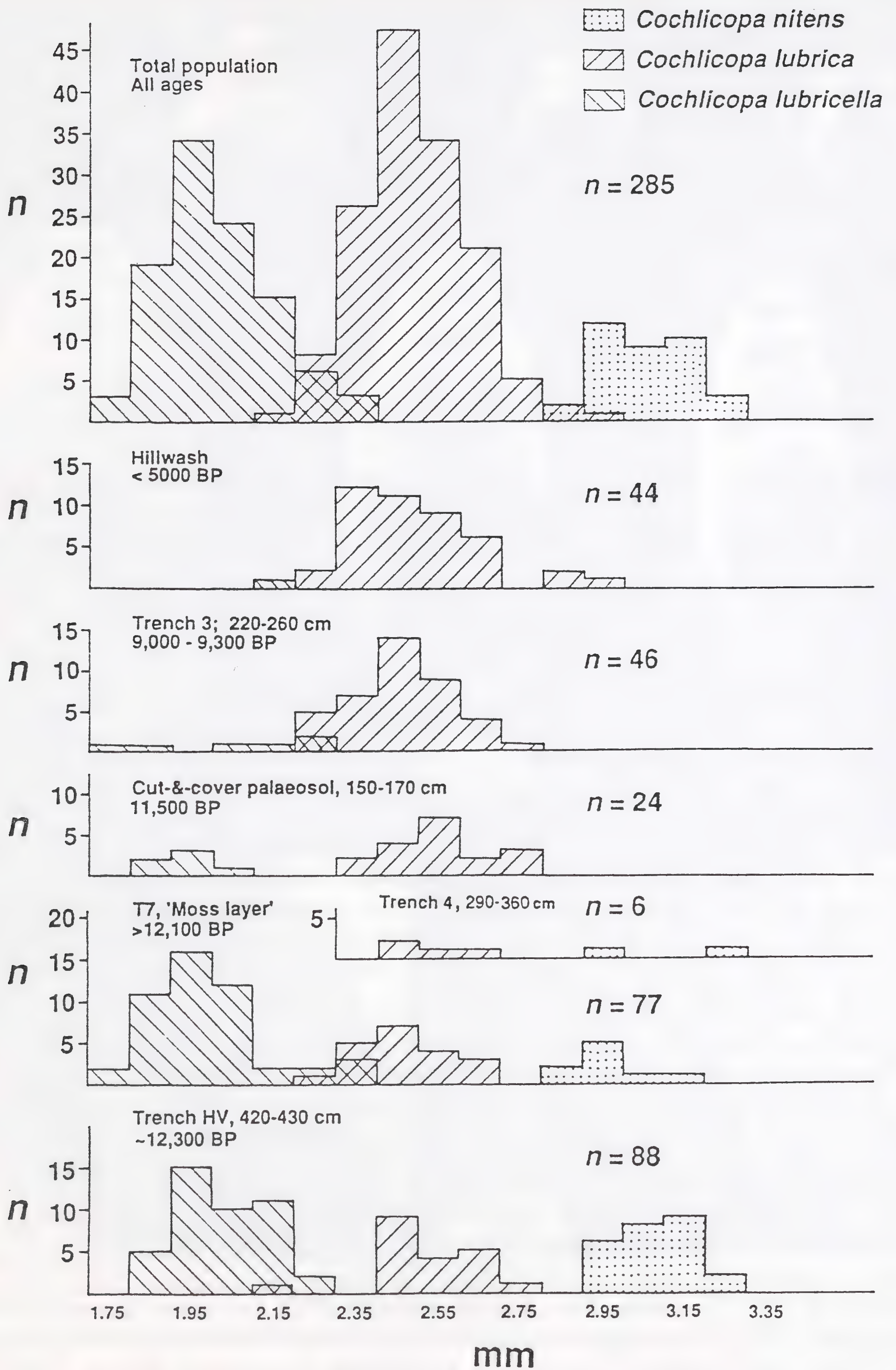


Fig. 2. Graphs plotting the breadths of *Cochlicopa* from a series of stratified samples from Holywell Coombe, Folkestone.

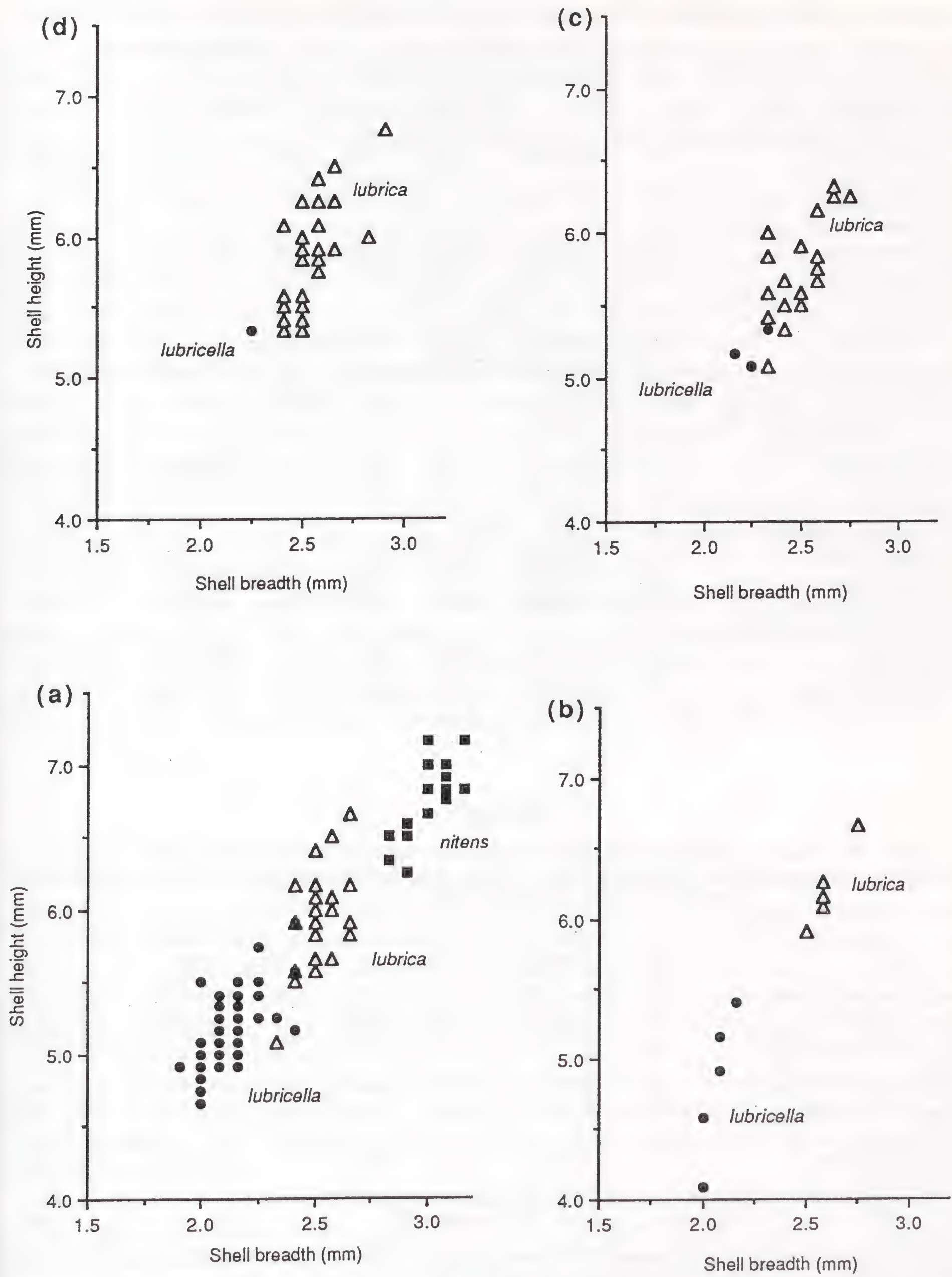


Fig. 3. Graphs plotting the measurements of shell height against shell breadth for a series of *Cochlicopa* from stratified samples from Holywell Coombe, Folkestone.
(a) 'Bølling Interstadial' (12–13,000 BP)
(b) 'Allerød soil', Cut-&-cover section (~11,500 BP)
(c) Early Post-glacial tufa, Trench 3 (9–9,300 BP)
(d) Late Post-glacial hill-wash. Main section, 30–112 cm (<5000 BP)

TABLE 1

Measurements of *Cochlicopa* populations from a series of stratified samples from Holywell Coombe, Folkestone.

		Shell breadth (mm)			Shell height (mm)				
		<i>n</i>	range	$\bar{x}$	sd	<i>n</i>	range	$\bar{x}$	sd
1.	Late post-glacial hillwash (<5000 BP). Main section								
	<i>Cochlicopa lubrica</i>	43	2.33–2.91	2.53	0.13	32	5.33–6.75	5.86	0.36
	<i>Cochlicopa lubricella</i>	1	—	2.25	—	1	—	5.33	—
2.	Early Post-glacial tufa (9–9,300 BP). Trench 3								
	<i>Cochlicopa lubrica</i>	40	2.33–2.75	2.50	0.10	30	5.08–6.33	5.72	0.28
	<i>Cochlicopa lubricella</i>	6	1.91–2.33	2.16	0.17	3	5.08–5.33	5.19	0.12
3.	‘Allerød soil’ (~11,500 BP) Cut-&-cover section								
	<i>Cochlicopa lubrica</i>	18	2.41–2.75	2.58	0.10	5	5.91–6.66	6.21	0.27
	<i>Cochlicopa lubricella</i>	6	2.00–2.16	2.06	0.06	5	4.08–5.41	4.82	0.51
4.	‘Bølling Interstadial’ (~12–13,000 BP). Organic muds								
(i)	Trench 4 (290–360 cm)								
	<i>Cochlicopa nitens</i>	2	2.91–3.16	2.79	0.27	2	6.25–7.16	6.70	0.64
	<i>Cochlicopa lubrica</i>	4	2.50–2.66	2.48	0.15	3	5.66–5.91	5.80	0.12
(ii)	‘Moss layer’, Below Sugarloaf Hill								
	<i>Cochlicopa nitens</i>	9	2.83–3.08	2.92	0.07	4	6.33–6.58	6.47	0.10
	<i>Cochlicopa lubrica</i>	20	2.33–2.66	2.50	0.09	17	5.08–6.50	5.93	0.32
	<i>Cochlicopa lubricella</i>	49	1.91–2.41	2.11	0.11	40	4.75–5.91	5.18	0.26
(iii)	Trench HV (420–430 cm)								
	<i>Cochlicopa nitens</i>	25	2.91–3.16	3.02	0.07	17	6.50–7.16	6.82	0.18
	<i>Cochlicopa lubrica</i>	20	2.25–2.75	2.55	0.10	12	5.58–6.66	6.13	0.27
	<i>Cochlicopa lubricella</i>	43	2.00–2.33	2.14	0.09	18	4.66–5.50	5.14	0.24

TABLE 2

Measurements of populations of *Cochlicopa nitens* (Gallenstein) from central Europe shown alongside composite data (i.e. all *C. nitens* measurements) from Holywell Coombe, Folkestone, Kent. Calculated from data given by Nilsson 1956^a, Ložek 1958^b and Hudec 1960^c. n.g. = not given.

	Shell breadth (mm)				Shell height (mm)			
	<i>n</i>	range	$\bar{x}$	sd	<i>n</i>	range	$\bar{x}$	sd
Holywell Coombe, Folkestone	36	2·83–3·16	2·99	0·09	23	6·25–7·16	6·75	0·25
Hildesborg (Schonen) ^a	38	2·90–3·20	3·06	0·08	38	6·25–7·25	6·76	0·31
Geniste der Gail near Villach (Austria) ^a	60	2·70–3·20	2·94	0·10	60	6·10–7·50	6·80	0·35
Dvorce near Lysá (Bohemia) ^b	10	2·81–3·07	2·94	0·07	10	6·22–7·01	6·52	0·25
Velké Jazero near Hrhov (Slovakia) ^b	5	2·84–3·10	3·02	0·10	5	6·51–7·50	7·03	0·38
Hodonín to Mikulčice, (Czechoslovakia) ^c	21	2·90–3·10	n.g.	n.g.	21	6·80–7·00	n.g.	n.g.

Differences in size are not the only characters that can be used to distinguish *C. nitens* from the other species. In comparison with *C. lubrica*, the whorls of *C. nitens* are also more tumid and the sutures much deeper (Fig. 1). In living specimens the shell is also a deeper brown and the fossils are generally also distinctly darker. Some authors have noted that the outer lip is relatively thinner in *C. nitens* but no obvious difference in peristome thickness was observed in the Folkestone fossils.

ASSOCIATED SPECIES

At Holywell Coombe the following species were recovered from the same stratigraphical levels as *C. nitens*: *Lymnaea truncatula*, *Pisidium casertanum*, *Catinella arenaria*, *Oxyloma pfeifferi*, *Cochlicopa lubrica*, *Cochlicopa lubricella*, *Vertigo antivertigo*, *V. pygmaea*, *V. genesii*, *Pupilla muscorum* (large form), *Vallonia costata*, *V. pulchella*, *Punctum pygmaeum*, *Vitrina pellucida*, *Deroceras/Limax*, *Euconulus fulvus* agg.

This assemblage, assignable to zone y (*sensu* Kerney, Preece & Turner 1980), is typical of a calcareous marsh and its composition is characteristic of similar communities reported from the early part of the Late-glacial (~12–13,000 BP). Radiocarbon dates from these levels have confirmed that they also fall within this time range (Preece 1991). The assemblage lacks several species such as *Carychium minimum*, *Nesovitrea hammonis*, *Arianta arbustorum* and *Trichia hispida* that do not appear until later in the Late-glacial (after ~11,500 BP).

Palaeobotanical evidence indicates that tree birches (*Betula pubescens*), juniper (*Juniperus communis*) and willows (*Salix*) were the dominant trees and shrubs. Rich herbaceous communities existed in and around the marsh itself and included *Carex rostrata*, *C. nigra*, *Juncus* spp, *Scirpus* (Section *Pterolepis*), *Diplotaxis tenuifolia*, *Silene vulgaris*, *Chenorhinum minus*, *Linum catharticum*, *Cerastium fontanum*, *Filipendula ulmaria*, *Mentha*, *Epilobium*, *Papaver* (Section *Scapiflora*), *Thalictrum*, *Artemisia*, Umbelliferae, *Valeriana* and *Parnassia palustris*. This plant community is very similar to that described by Nilsson (1956: 293) for a site with living *C. nitens* in Czechoslovakia.

Rich assemblages of insects, in particular beetles, were also recovered from the same levels. These suggest that the prevailing climate at Folkestone was temperate with temperatures during the warmest month between 17–19° C and those of the coldest month between –7 and 3° C. The fossil assemblages therefore indicate interstadial conditions and the stratigraphical context suggest correlation with the so called ‘Bølling Interstadial’.

DISCUSSION

The occurrence of *C. nitens* at Holywell Coombe constitutes the first record from the British Late-glacial. There are three further points of interest. First, *C. nitens* apparently co-existed with both *C. lubrica* and *C. lubricella*, the last species being the most common, a rather unexpected discovery given the damp nature of the depositional environment. Second, it was associated with several marsh species, such as *Catinella arenaria* and *Vertigo genesii*, that are commonly regarded as having arctic-alpine affinities at the present-day. However, the associated fossils indicate that the climate was not excessively cold but was of interstadial character. Third, it was only found in sediments that accumulated in marshes during the early part of the Late-glacial. The reasons for its absence from later deposits may have something to do with changes in the local hydrology resulting in an alteration in the character of the marsh.

C. nitens has now been found in several British Late Pleistocene interglacial sites (such as at Shropham, Norfolk) since its original discovery in an Ipswichian (Last) interglacial site in Lincolnshire (Holyoak & Preece 1985). At these sites it is always associated with much more diverse molluscan communities that include species such as *Vertigo moulinsiana*, *V. angustior* and *Vallonia enniensis*. This is perhaps not surprising in view of Ložek’s (1958: 73) statement that *C. nitens* is “an ecologically highly specialised species which occurs only in calcareous swamps, like *Vertigo moulinsiana* (Dupuy)”. The surprise is that it occurs as part of the early pioneer community during the Late-glacial, some two thousand years before the first appearance of *Vertigo moulinsiana*. This is precisely the situation that Ložek (1958) has

reported from Czechoslovakia where *C. nitens* also occurs in communities of Late-glacial character (with *Vertigo genesii* and *Columella columella*) long before the appearance of *V. moulinsiana*. He took this to indicate that *C. nitens* is the more tolerant of cold climates. Nyilas & Sümegi (1989, 1992) have also reported the occurrence of *C. nitens* in a Pleistocene deposit in Hungary, where it was associated with *Columella columella*. Elsewhere it was also present in the early phases of interglacials and was evidently not uncommon in the early Post-glacial.

The discovery of *C. nitens* in the Late-glacial at Folkestone prompted a re-examination of other fossil *Cochlicopa* in my collection. Shells of *C. nitens* were recognized from the following sites:

(i) *Great Harrowden, Northamptonshire* (SP 875695)

In 1970 Dr. R. J. Chandler (Imperial College, London) sampled temporary trench sections which exposed a tufa overlying a grey silt with a gravel base resting on Upper Lias Clay. A soil horizon separated the top of the grey silt from the base of the tufa. Two radiocarbon dates have been obtained from this level. The younger date of 9435 ± 610 BP (St-3695) was obtained from the soil itself (? contaminated), the older date of $11,980 \pm 145$ BP (St-3685) was derived from organic lenses immediately underlying the main soil. Lists of the molluscan faunas from the silt and tufa have been published by Preece (1978). *C. nitens* has now been recognized from samples of the silt, where again it was associated with *Catinella arenaria*, *Vertigo genesii* and *Vertigo geyeri*.

(ii) *Caerwys, Clywd, North Wales* (SJ 128718)

This is a large tufa quarry behind the Pwll Gwyn Inn on the A541. Tufa reaching 15m thick rests on red fluvio-glacial sands and gravels. It is variable in lithology and apart from thin units of basal Late-glacial material, most of the tufa accumulated during the early Post-glacial (5–10,000 BP). McMillan & Zeissler (1985) reported the discovery of *C. nitens* in the tufa and I have also found this species here but *only* in deposits that accumulated during the earliest part of the Post-glacial period (~9–10,000 BP). Associated species again included *Vertigo genesii* but also species such as *V. substriata*, *V. antivertigo* and *Carychium minimum*.

(iii) *Castlethorpe, Lincolnshire* (SE 975077)

This site was situated approximately half-way between the Springfield plantation and Castlethorpe Hall. At this point a moderately large area of detrius mud lined the bed of the stream and could be traced into the banks where it was overlain by a thin layer of sand and finally tufa. A detailed biostratigraphical study of this site has been published by Preece & Robinson (1984). Juvenile shells of *C. nitens* were present between 85–90 cm, which can confidently be assigned to the early Post-glacial period (~9–9,500 BP). Preece & Robinson (1984: 333) give a full list of the fauna from this level, which includes species such as *Vertigo geyeri*, *V. moulinsiana*, *Discus ruderratus* and *Nesovitrea petronella*.

A re-examination of the fossil *Cochlicopa* in the A. S. Kennard collection housed in the British Museum (Natural History) revealed further specimens of *C. nitens* from neighbouring tufa deposits at 'Scawby' and from 'Broughton-Brigg' in Lincolnshire. The precise age of these shells cannot be given but it is clear from the published account (Kennard & Musham 1937) that they are also likely to be of early Post-glacial, rather than Late-glacial, age.

Most of the modern records of *C. nitens* are from calcareous fens and marshes but it has sometimes been found in very wet calcareous woodland. Today it is an uncommon species known from only a few scattered localities in central and eastern Europe (Kerney, Cameron & Jungbluth 1983). According to Nilsson (1956) these isolated populations are thought to be outliers of a more eastern-continental Eurasian range.

ACKNOWLEDGEMENTS

Thanks are due to Eurotunnel for funding the recent work at Holywell Coombe, Folkestone. I would also like to thank Mary Pettit and Russell Coope for their comments on the palaeobotany and insects respectively.

REFERENCES

- EHRMANN, P., 1933. (facsimile reprint 1956). *Die Tierwelt Mitteleuropas. II (I). Weichtiere, Mollusca*. Leipzig: Quelle & Meyer.
- HOLYOAK, D. T. & PREECE, R. C., 1985. Late Pleistocene interglacial deposits at Tattershall, Lincolnshire. *Phil. Trans R. Soc. Lond. B*, **311**: 193–236.
- HUDEC, V., 1960. Critical evaluation of the species of the genus *Cochlicopa* Risso 1826 (Mollusca) found in Czechoslovakia. *Práce Brněn. Česk. Akad. Věd*. **32**: 277–299.
- KENNARD, A. S. & MUSHAM, J. F., 1937. On the Mollusca from a Holocene tufaceous deposit at Broughton-Brigg, Lincolnshire. *Proc. malac. Soc. Lond.* **22**: 374–379.
- KERNEY, M. P., CAMERON, R. A. D. & JUNGBLUTH, J. H., 1983. *Die Landsnecken Nord- und Mitteleuropas*. Paul Parey. Hamburg/Berlin.
- KERNEY, M. P., PREECE, R. C. & TURNER, C., 1980. Molluscan and plant biostratigraphy of some Late Devensian and Flandrian deposits in Kent. *Phil. Trans R. Soc. Lond. B*, **291**: 1–43.
- LOŽEK, V., 1958. *Cochlicopa nitens* (Kokeil) in Czechoslovakia. *Basteria*, **22**: 69–74.
- McMILLAN, N. F. & ZEISSLER, H., 1985. The tufa deposit at Caerwys, North Wales, and its molluscan fauna. *Amateur Geologist* **11**: 3–11.
- MANDAHL-BARTH, G., 1950. Danske landsegle. *Flora og Fauna*. 56. Köbenhavn.
- NILSSON, A., 1956. *Cochlicopa nitens* (Kokeil) Gallenstein und *C. minima* Siemashko, zweis selbständige Arten im Formenkreis der kollektiven *C. lubrica* (Müller). *Ark. Zool.* **9**: 281–304.
- NYILAS, I. & SÜMEGI, P., 1989. Pointing out *Cochlicopa nitens* (Gallenstein, 1848) a new species for the Pleistocene in Hungary, in the territory of the Hortobágy National Park. *Soosiana* **17**: 113–115.
- & 1992. The mollusc fauna of Hortobagy at the end of the Pleistocene (Würm 3) and in the Holocene. *Proc. Tenth Intern. Malacol. Congr.* (Tübingen 1989): 481–486.
- PREECE, R. C., 1978. The Northamptonshire tufas and their molluscan faunas. *J. Northampt. nat. Hist. Soc. Fld Club*. No **260**: 171–174.
- , 1991. Accelerator and radiometric radiocarbon dates on a range of materials from colluvial deposits at Holywell Coombe, Folkestone. In: Lowe, J. J. (ed.) *Radiocarbon dating: recent applications and future potential*. *Quat. Proc.* **1**: 43–51.
- , 1992. Episodes of erosion and stability since the Late-glacial: the evidence from dry valleys in Kent. In: Bell, M. & Boardman, J. (eds). *Soil erosion: past and present*. Oxbow Books, Oxford.
- & ROBINSON, J. E., 1984. Late Devensian and Flandrian environmental history of the Ancholme Valley, Lincolnshire: molluscan and ostracod evidence. *J. Biogeogr.* **11**: 319–352.
- QUICK, H. E., 1954. *Cochlicopa* in the British Isles. *Proc. malac. Soc. Lond.* **30**: 304–213.
- WALDÉN, H. W., 1955. The land Gastropoda of the vicinity of Stockholm. *Ark. Zool.* **7**: 391–448.
- ZILCH, A. & JAECKEL, S. G. A., 1962. *Ergänzung Die Tierwelt Mitteleuropas: Weichtiere, Mollusca*. Leipzig: Quelle & Meyer.

NOTE ADDED IN PROOF

Since the above paper was written, two papers were presented at the 11th International Malacological Congress in Siena (Italy) which have a direct bearing on the systematics of European *Cochlicopa*.

The first, by Faulkner (1992), confirmed Hudec's (1960) discovery that in *Cochlicopa*, despite considerable variability, there are basically two different types of male copulatory organ: (1) the 'lubrica-type' characterized by a voluminous, mostly unpigmented structure, especially the thick, white distinctly separated epiphallus and the long structured penial

appendix with large bulbous ampulla and (2) the 'repentina-type' in which the male copulatory organ is comparatively small and usually strongly pigmented, the vas deferens generally passes smoothly into the slim epiphallus and the penial appendix is short and inconspicuously structured with a small cylindrical ampulla. *C. lubricella* and *C. nitens* apparently have male copulatory organs of the 'repentina-type'. Faulkner dissected specimens of the conchologically inseparable *lubrica*/*repentina*-group from many localities in Europe and found, very surprisingly, that the 'repentina-type' is about ten times as common as the 'lubrica-type' and that *C. repentina* Hudec must be considered the most common and widespread *Cochlicopa* in Europe. Faulkner also dissected specimens from sites around Frederiksdal, near Copenhagen, Müller's type-locality for *lubrica*, and found that both 'lubrica' and 'repentina-types' were represented.

In a second paper Gittenberger & Bakker (1992) showed that in a small area north of the Hague in the Netherlands, three distinct morphological forms of *Cochlicopa* occurred with mean widths of 1.93, 2.06 and 2.25 mm respectively. Samples were measured over a 5-year period and these forms were found to be morphologically very stable, although there were fluctuations in their annual frequencies. Since they occurred sympatrically and behaved independently they were clearly not merely ecophenotypes. In the discussion Dr H. W. Waldén commented that in Sweden he has similarly found no fewer than five morphological forms of *Cochlicopa*.

My paper was written primarily to demonstrate the occurrence of *C. nitens* as a Late-glacial and Holocene fossil in Britain. In the light of the above papers the comparative data on the smaller taxa may also contribute to the active debate on the systematics of European *Cochlicopa*. Precisely what names ought now to be applied to this material, or indeed any other material that has not yielded anatomical information, has become an open question.

ADDITIONAL REFERENCES

- FAULKNER, G., 1992. The slippery snails of Frederiksdal: revision of *Helix lubrica* O. F. Müller 1774 at its type locality (Gastropoda, Stylommatophora: Cochlicopidae). *Abstr. 11th Intern. Malacol. Congr., Siena*: 337–340.
- GITTENBERGER, E. & BAKKER, K., 1992. Five years collecting *Cochlicopa* (Gastropoda, Pulmonata, Pupillacea): stability in shell-size and microgeographical distribution. *Abstr. 11th Intern. Malacol. Congr., Siena*: 341–344.

TURBO JONATHANI, A NEW TURBINID SPECIES FROM THE SOUTHERN COAST OF OMAN (GASTROPODA: TURBINIDAE)*

H. DEKKER¹, R. G. MOOLENBEEK¹ AND S. P. DANCE²

(Accepted for publication, 16th May, 1992)

Abstract: A new species, *Turbo jonathani*, is described from shallow water off the Dhofar coast of southern Oman. It is compared with several other *Turbo* species, including the Panamic *T. fluctuosus* Wood, 1828, which resembles it in ornament and colour pattern and has a rather similar radula. The operculum of *T. jonathani* is quite distinct.

Keywords: Gastropoda, Turbinidae, Oman, upwelling, endemism

INTRODUCTION

The molluscan fauna of Dhofar in the southern half of the Sultanate of Oman is varied but poorly known (Barratt 1984). The rocky coastline is mostly composed of sedimentary limestones and there is a limited area of contrasting metamorphic rocks around the Marbat peninsula. The prevailing monsoon gyre influences this coastline. In summer the south-westerly monsoon causes an upwelling of cold, nutrient-rich water off southern Oman coasts and this produces floral and faunal communities which are not typical of the Indo-West-Pacific region. The rocky shore communities are not very diverse and seasonal differences in species composition and distribution have been observed (UNEP 1985). Taylor & Smythe (1985) have noted a significant endemism in the molluscan fauna and have described a new calyptraeid gastropod, *Trochita dhofarensis*, a species apparently congeneric with two other species found only on the west coasts of South and Central America (Keen 1971). Among other molluscan species noted by Barratt (1984) as being endemic to southern Oman or limited to the northern Indian Ocean are *Cymatium ranzanii*, *Haliotis mariae*, *Sinistralia gallagheri*, *Bursa bardeyi* and an undescribed *Turbo*. Our own collections from the Marbat peninsula include specimens of the same species of *Turbo* which we describe below.

SYSTEMATIC DESCRIPTION

Turbo jonathani n. sp. (Figs. 1–6)

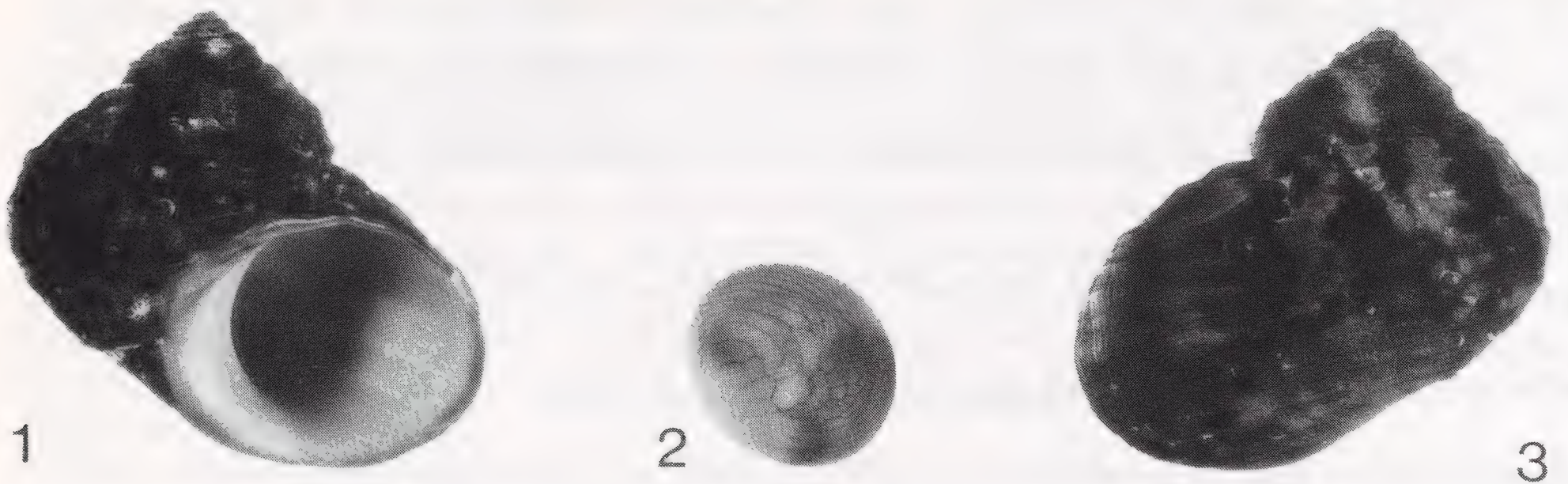
Description of holotype

Zoological Museum, Amsterdam (ZMA Moll. 3.92.035, shell with operculum and dried animal, collected by Una Dance, 14 November 1991): Shell solid, moderately glossy, turbiniform: length 35.5 mm, width 35.0 mm (Figs. 1,3). Protoconch and early teleoconch

* Studies on the marine molluscan fauna of Oman, No. 4.

¹ University of Amsterdam (Zoological Museum), P.O. Box 4766, 100g AT Amsterdam, The Netherlands

² Cavendish House, 83, Warwick Road, Carlisle CA1 1EB



Figs. 1–3. *Turbo jonathani*, Dekker, Moolenbeek & Dance n.sp. holotype (ZMA Moll. 3.92.035), east of Marbat, Dhofar Province, Oman, November 1991.

Fig. 1. Ventral view of shell, length 35.5 mm. Fig. 2. Outer surface of operculum. Fig. 3. Dorsal view of shell.

whorls eroded; about 4–5 teleoconch whorls rounded and separated from each other by a deep suture which becomes a broad channel above the last whorl; the thin-edged outer lip is broadly expanded below the periphery. About 16 broad widely spaced, gently rounded, spiral cords on the last whorl; those near the periphery more keeled. Regular, crowded and flattened, prosocline growth ridges cover the whorls. Columella smooth, gently curved and thickened at its base; columellar callus rather thick. No umbilicus.

Colour: Reddish brown mottled with white and chocolate brown axial bands, the white mottlings being more developed above the periphery; basal spiral ridges decorated with white and dark brown to blackish patches. Aperture pearly white, brown at outer edge.

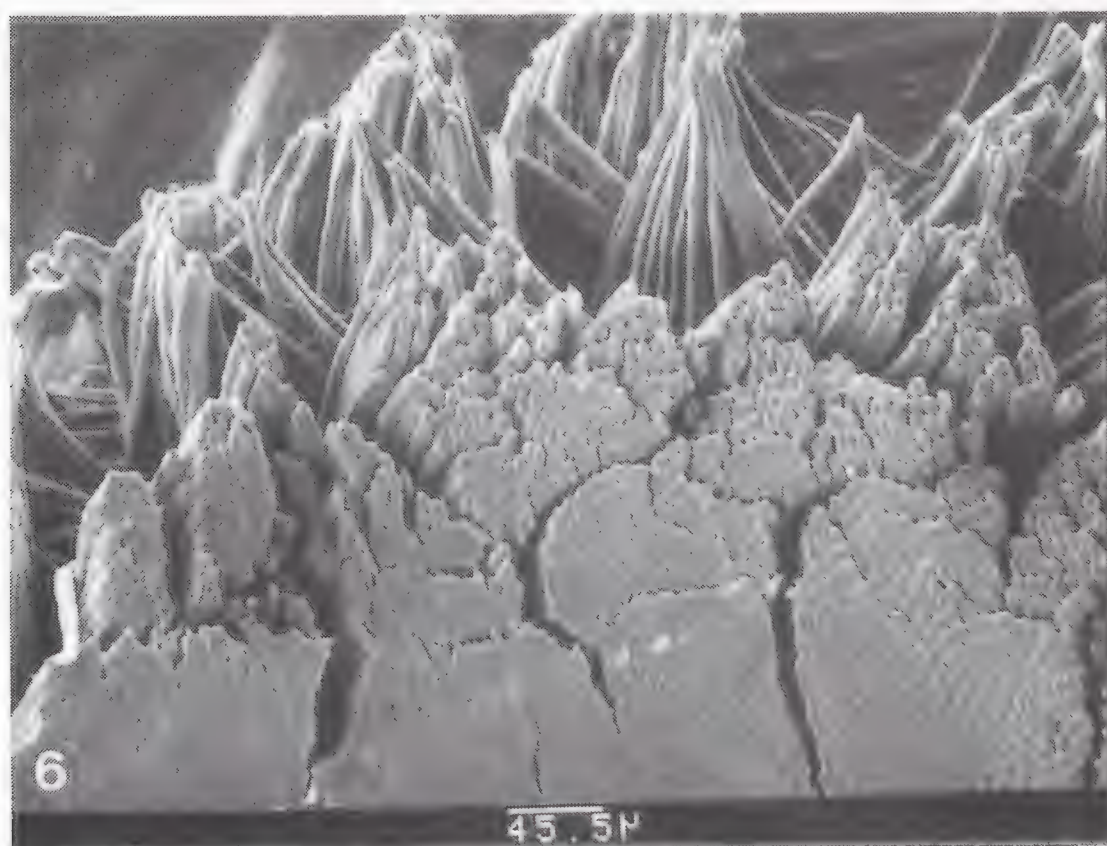
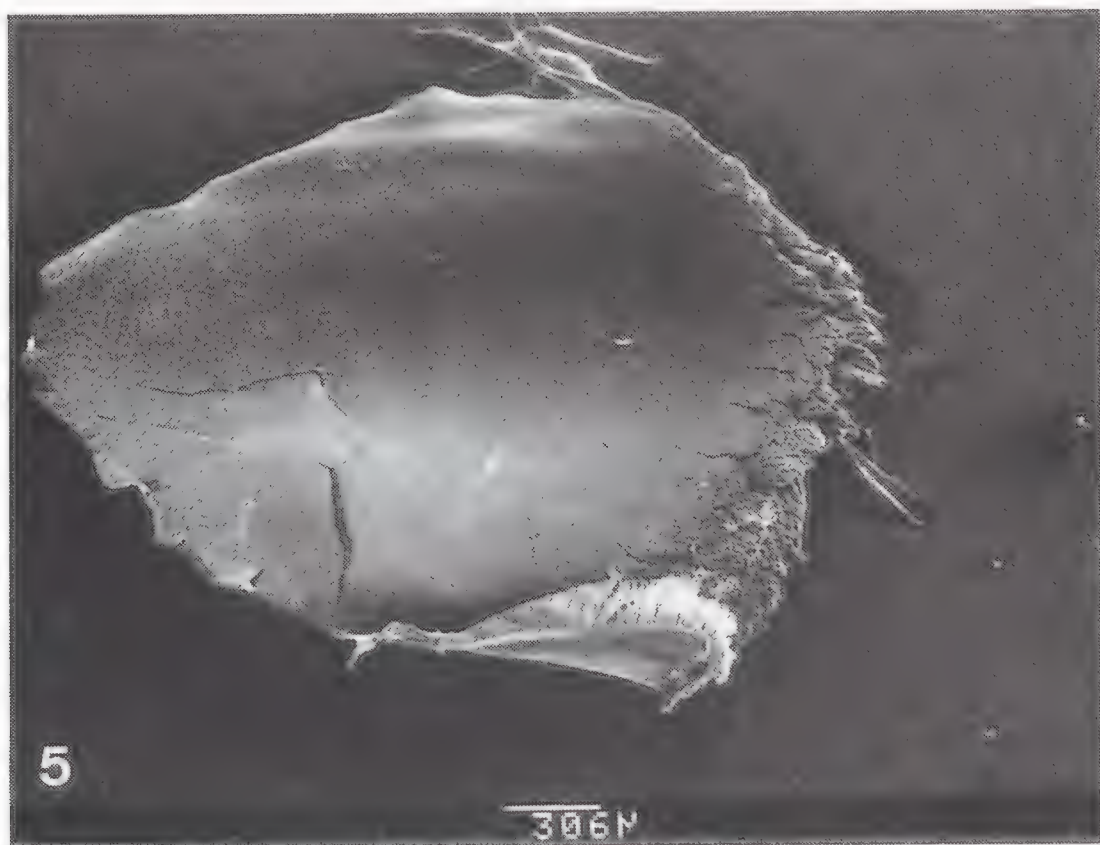
Operculum: Ovate, length 15.8 mm, width 14.0 mm, 5.5 mm thick (Fig. 2). Outer surface has flattened convolutions resembling those of the human brain, encircled by a band of small, elongated, concentric spirals. Colour greyish green except for a white to creamy patch towards the columellar edge; inner side spirally coiled (about 6 whorls), covered by a thin, brown periostracum.

Radula: Central tooth field reduced. Rachidian asymmetric (Fig. 4); 5 pairs of lateral teeth; about 20 marginal teeth, the inner marginals enlarged, with prominent pointed cusps. Outer marginals slender, with 4–8 serrations. Jaws well developed, horny brown, with a hexagonal structure, comprising numerous, slender fibres (Figs 5–6).

Type locality: 7 km east of Marbat, Dhofar Province, Sultanate of Oman. Shells collected on the beach.

Variation of paratypes

At the type locality 16 paratypes (ZMA Moll. 3.92.036) were collected by H. Dekker and R. G. Moolenbeek; a further 22 paratypes were collected by other members of our team: D. T. and E. Bosch, S. P. and U. Dance. Although many of the paratypes are eroded most retain the characteristic, flattened, prosocline ridges which vary only in strength. The spiral cords vary considerably in strength and number. The colour pattern also varies considerably, the browns often faded to beige, orange or yellowish pink; sometimes the mottlings are sparsely distributed and vary from off-white to greenish but are usually present on the upper half of the last whorl. When the outer surface of the operculum is worn smooth the resultant colour pattern resembles that displayed by a spiral nebula, with white radial spokes against a reddish-brown background. Maximum length 38 mm, although an operculum with length 26.0 mm suggests that larger specimens occur at the type locality.



Figs. 4–6. *Turbo jonathani* Dekker, Moolenbeek & Dance n.sp. paratype.

Fig. 4. Radula, central teeth at right side, enlarged inner marginal teeth at centre. Fig. 5. Half of a jaw. Fig. 6. Lower part of jaw, showing hexagonal structure with fibres.

Paratypes will be given to the Natural History Museum of Oman (Muscat), the Natural History Museum (London), the National Museum of Wales (Cardiff), the Manchester Museum (Manchester, England), the Royal Museums of Scotland (Edinburgh), the American Museum of Natural History (New York), the Los Angeles County Museum, and the National Museum of New Zealand (Wellington).

Other material studied/distribution

We studied 29 specimens, also from the Marbat area, in the collection of the late Kathleen R. Smythe (now at the Natural History Museum, London). In October 1983 Dr. J. D. Taylor collected 71 living specimens (at the Natural History Museum, London) from boulders at a depth of 1–3m, at Wadi Haart, between Marbat and Sudh. As far as we know, the distribution range of this species is limited to the Marbat Peninsula.

Etymology

The new species is named after a zealous collector of shells from Oman and the Gulf, Jonathan Bosch, grandson of D. T. Bosch and his wife Eloise.

Remarks

As stated in UNEP (1985) "the uniqueness of the Dhofar system lies in its total annual decline and recovery with the life cycles of the relevant species" and/or seasonal "migration into deeper water". According to J. D. Taylor (personal communication to S. P. Dance) living specimens of *T. jonathani* were plentiful in shallow water near Sudh in October 1983. In spite of our intense collecting activity offshore at the nearby type locality, using snorkelling gear, we found no living specimens in November 1991. Either this new species has a patchy distribution or, we suppose, it moves into deeper water about October and/or November. *T. jonathani* is easily distinguished from other Indian Ocean species of *Turbo* by the surface ornament, the deeply channelled suture, the broadly expanded outer lip and the peculiar ornament and colour of the operculum's outer-surface. The Indo-Pacific *T. marmoratus* L. 1758 and the Panamic *T. fluctuosus* Wood, 1828 each have a similar prosocline growth ornament and colour pattern but they lack a deeply channelled suture. That feature exists in the West Indian *T. canaliculatus* Hermann, 1781, but is more pronounced. There are superficial similarities to *T. bruneus* (Röding, 1798) but this species, which occurs in the waters of southern Oman and Masirah, has a small umbilicus, more pronounced spiral ridges, and is more mottled. The operculum of each of these species is also differently ornamented. As there is an apparent generic relationship between *Trochita dhofarensis* and two exclusively Panamic species of *Trochita*, it is worth noting the close similarity between the radulae of *Turbo jonathani* and *T. fluctuosus* (see Hickman & McLean, 1990:58, figs C, E). Molluscs living in the waters of the Panamic region (and other regions where *Trochita* species are known to live) are also influenced by cold upwellings. An interesting discussion of the wider implications of cold upwelling systems on the distribution of molluscs, with references, is provided by Taylor & Smythe (1985).

ACKNOWLEDGEMENTS

We are grateful to Dr. D. T. Bosch for enabling us to participate in this project and to him and his wife Eloise for help and hospitality during our stay in Oman; to Mr. J. W. Creutzberg, Managing Director of KLM Oman, for arranging a courtesy air ticket from Amsterdam to Seeb; and to all the members of our research team and local residents in Oman for their enthusiastic help. Dr. J. D. Taylor of the Natural History Museum (London)

kindly lent some specimens of the new species collected by himself. L. van der Laan of the Zoological Museum, Amsterdam, was responsible for the photographs; SEM pictures were made at the Laboratorium voor Elektronenmikroskopie, University of Amsterdam.

REFERENCES

- BARRATT, L. (ed.), 1984. Ecological studies of rocky shores on the south coast of Oman. *Report of IUCN to UNEP Regional Seas Programme, Geneva*.
- HICKMAN, C. S. & McLEAN, J. H., 1990. Systematic revision and suprageneric classification of trochacean gastropods. *Nat. Hist. Mus. L. A. County, Science Series* **25**: 1–169.
- KEEN, A. M., 1971. *Seashells of tropical West America*. Stanford University Press, Stanford, California, pp. 1064, illust.
- TAYLOR, J. D. & SMYTHE, K. R., 1985. A new species of *Trochita* (Gastropoda: Calyptraeidae) from Oman: a relict distribution and association with upwelling areas. *J. Conch., Lond.* **32**: 39–48.
- UNEP, 1985. An ecological study of the rocky shores on the southern coast of Oman. *UNEP Regional Seas Reports and Studies* **71**: 1–14.

UMBONIUM ELOISEAE (GASTROPODA: TROCHIDAE), A NEW TROCHID SPECIES FROM MASIRAH ISLAND, OMAN*

S. P. DANCE¹, R. G. MOOLENBEEK² AND H. DEKKER²

(Accepted for publication, 16th May, 1992)

Abstract: A new trochid species, *Umbonium eloiseae*, is described, collected at Masirah Island, Sultanate of Oman. Its colour pattern varies less than that of the other Indian Ocean species, *U. vestiarius* and its external anatomy resembles that of the tribe Bankiviini.

Keywords: Gastropoda, Trochidae, *Umbonium*, Oman, endemism, upwelling

INTRODUCTION

The trochid genus *Umbonium* occurs in limited areas of the Indo-Pacific, the various species (all or most of them filter feeders) living in the surface layers of marine sands in shallow water or mud flats. Until now only one species has been recorded from the Indian Ocean, *Umbonium vestiarius* (L., 1758). Fretter (1975) gives its distribution as from Sri Lanka to Japan but it has also been recorded from the Arabian Gulf (Biggs 1973, Smythe 1982) and from Oman (Bosch & Bosch 1982); it occurs in astronomical numbers near Muscat, Oman, where we collected it in November 1991. During field work around Masirah Island, where marine life is influenced by the cold upwelling system typical of southern Oman, our team discovered a smaller *Umbonium* species on sandy mud flats near the village of Sur Masirah, on the west coast of the island. It was immediately distinguishable from *U. vestiarius* by its rosy pink colour and dark brown to reddish apex. Based on shell morphology, external anatomy and radula characters, we believe it represents a new species which is described below.

SYSTEMATIC DESCRIPTION

Umbonium eloiseae n.sp. (Figs. 1–14)

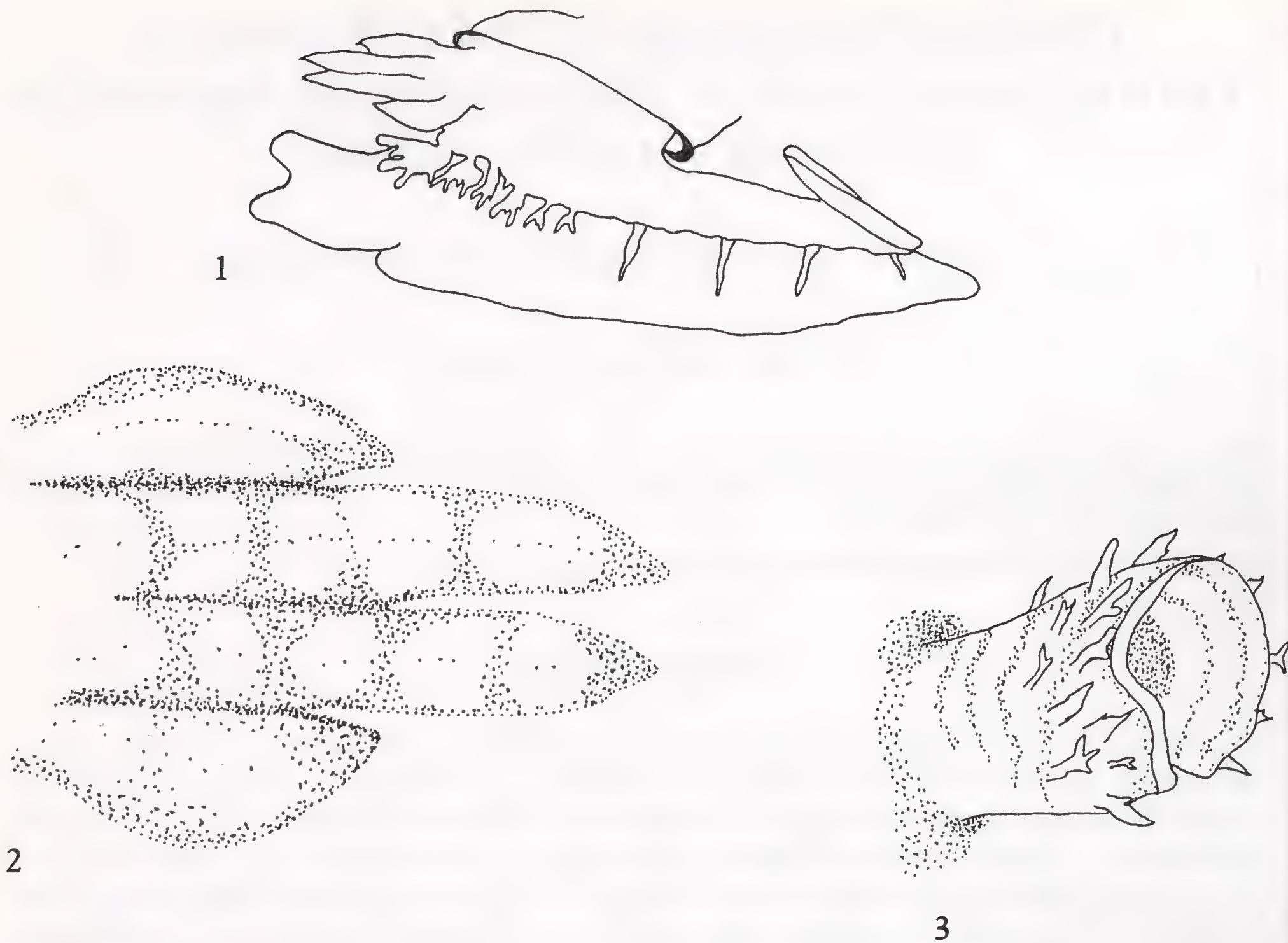
Description of holotype

Zoological Museum, Amsterdam (ZMA Moll. 3.92.033, shell with operculum and animal collected by R. G. Moolenbeek, 22 November 1991): Shell solid, glossy, depressed-conical, much wider than long; diameter 9.0 mm, length 5.1 mm (Figs. 4–6). Tightly coiled protoconch is succeeded by 4 regularly expanding whorls each separated by a fine, adpressed suture; the last whorl is roundly keeled. Aperture broadly half-moon-shaped, the outer lip thin and smooth; columella strongly curved and smooth, its base ending in a large, smooth, rounded callus (Fig. 5) which completely covers the umbilical region; the callus is surrounded by a shallow groove. Except for the smooth, shiny callus the entire shell is covered by fine spiral striae which give it a silky appearance.

* Studies on the marine molluscan fauna of Oman, No. 5.

¹ Cavendish House, 83, Warwick Road, Carlisle CA1 1EB

² University of Amsterdam (Zoological Museum), P.O. Box 4766, 100g AT Amsterdam, The Netherlands



Figs. 1–3. *Umbonium eloiseae* n.sp.

Fig. 1. Animal removed from shell to show external anatomy (length approximately 6 mm).

Fig. 2. Head with cephalic tentacles and eye-stalks (length 0.67 mm).

Fig. 3. Snout with papillae (length 0.35 mm).

Colour: Protoconch and first 2 teleoconch whorls dark reddish brown; other teleoconch whorls rosy pink. Just below the sutures and around the umbilical callus is a narrow white band. At the periphery is a band of white, nearly rectangular spots with pale brown spots in their intervals. Older callus in umbilicus is more intense pink.

Operculum: Multispiral, about 8–9 whorls, outer side dull, inner side shiny, amber coloured, its final whorl translucent; diameter about 2.5 mm.

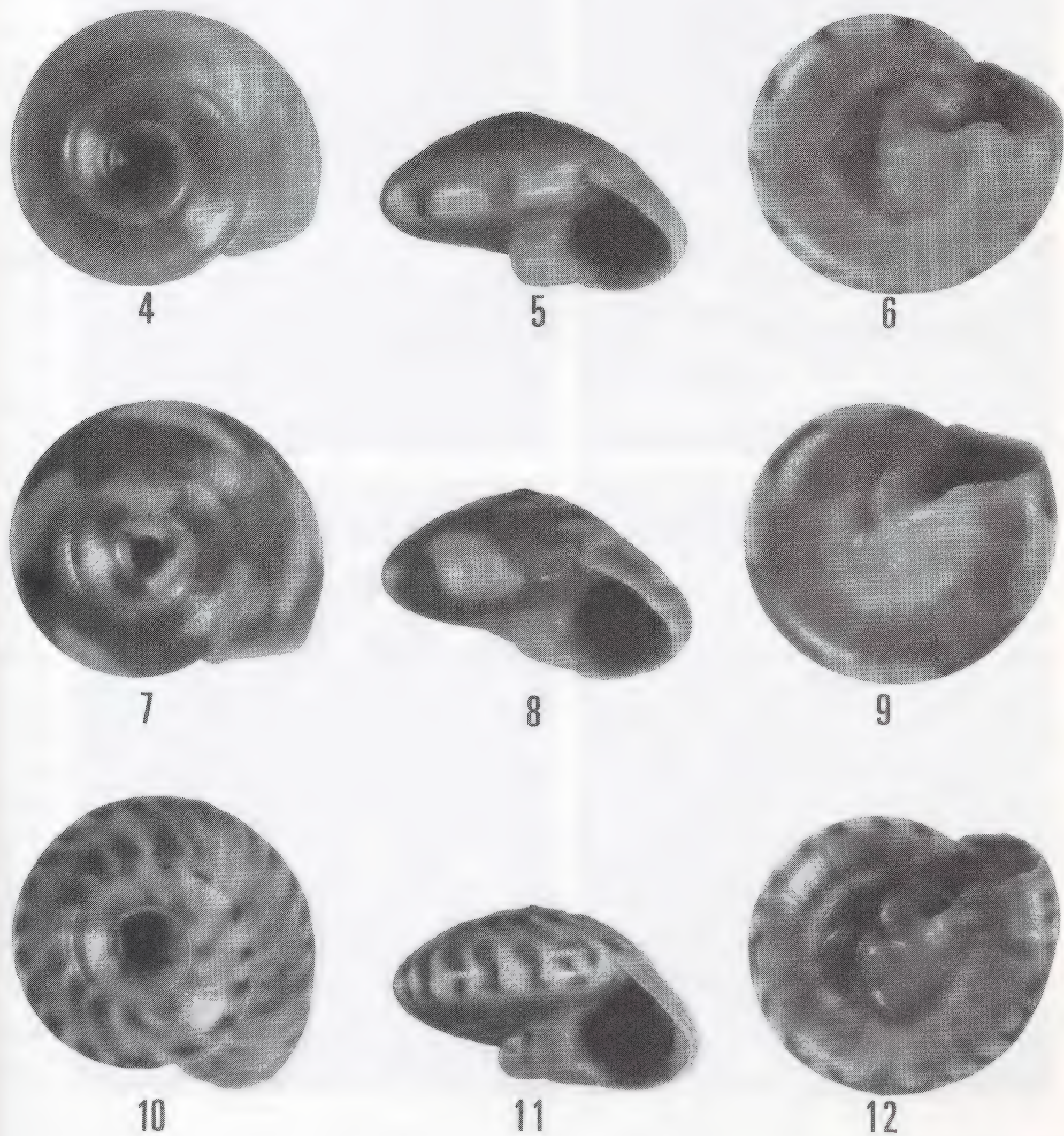
Radula: Small compared with that of other trochids of similar size; central teeth poorly developed, lacking shafts and cusps (Fig. 13). Rachidian and lateral teeth oval and thickened along their margins. The numerous marginal teeth are serrated (Fig. 14).

Type locality

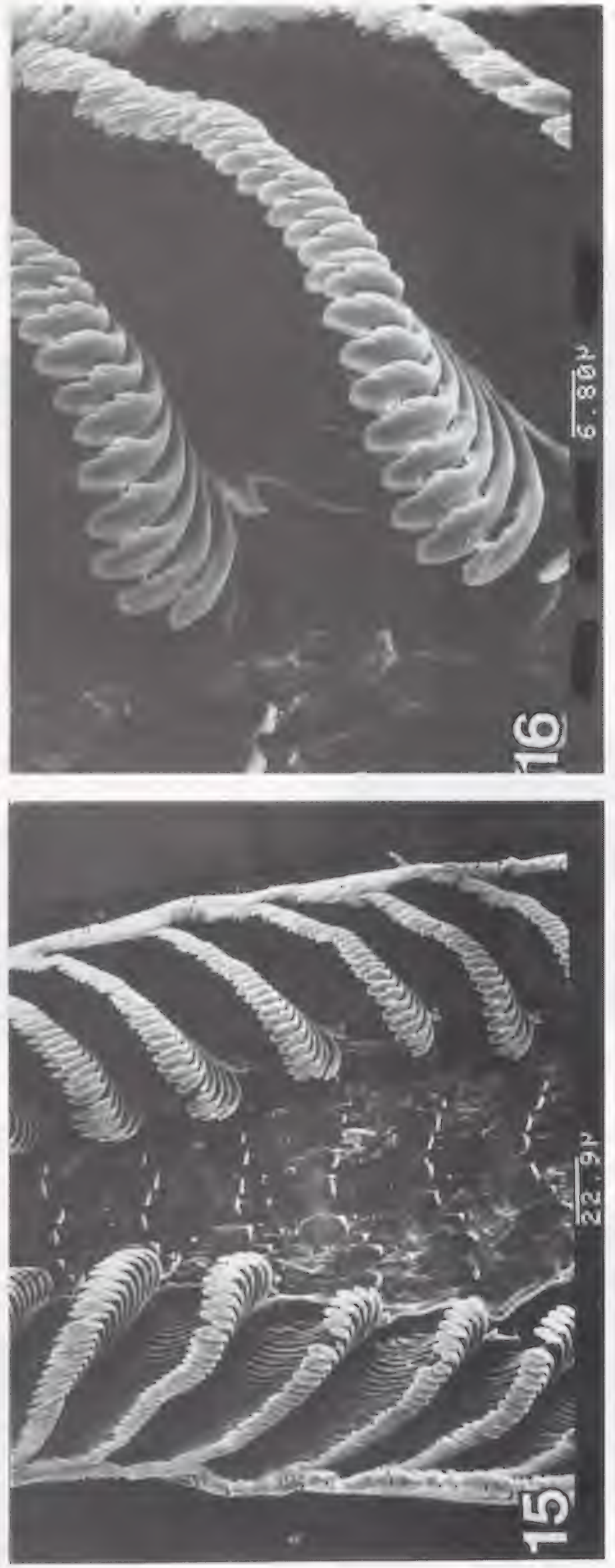
Sur Masirah, west coast of Masirah Island, Sultanate of Oman. Living specimen collected, with others, on sandy mud flat, 22 November 1991, by R. G. Moolenbeek and H. Dekker.

Paratypes

All paratypes are from the type locality and of these 380 are dry, 26 preserved in alcohol (ZMA Moll. 3.92.034). R. G. Moolenbeek, H. Dekker and S. P. Dance collected many paratypes with the holotype on 22 November 1991. Between 1989 and 1991 D. T. Bosch and Miss Aniesa Bosch collected dead specimens on several occasions at the type locality. Paratypes will be given to the Natural History Museum of Oman (Muscat), the Natural History Museum (London), the National Museum of Wales (Cardiff), the Manchester



Figs. 4–12. *Umbonium eloiseae* n.sp. Sur Masirah, Masirah Island, Oman. 4–6 holotype: diameter 9.0 mm; 7–9 paratype: diameter 8.0 mm; 10–12 paratype: diameter 8.8 mm.



Figs. 13–14. *Umbonium eloiseae* n.sp. Radula of paratype from Sur Masirah, Masirah Island, Oman.
Figs. 15–16. *Umbonium vestiarium* (L., 1758). Radula of specimen from Qurm, near Muscat, Oman, collected November 1991.

Museum (Manchester, England), the Royal Museums of Scotland (Edinburgh), the American Museum of Natural History (New York), the Los Angeles County Museum, and the National Museum of New Zealand (Wellington).

Variation of paratypes

The many paratypes show little variation in shell shape and ornament. The rosy pink ground colour is almost constant but the pattern varies (Figs. 4–12) although less so than in most other species of *Umbonium*. In dead, crabbed or sun-bleached specimens the apical whorls become purple. In some specimens the white spots at the periphery are larger and occur also on earlier whorls (Figs 7–9). Other paratypes have the darker areas at the periphery more pronounced, the smaller white areas forming prosocline axial bands (Figs 10–12). Largest paratype: diameter 9.5 mm, length 5.0 mm. We examined the external anatomy of preserved animals taken from several paratypes. The cephalic tentacles are of equal dimensions (length 0.67 mm, diameter 0.07 mm). Epipodium with left neck-lobe subdivided into 8 branch-like tentacles (Fig. 1). Right neck-lobe folded, probably used, when rolled up, as an exhalant siphon. Eystalks pointed, without terminal eyes, diameter 0.4 mm, length 4.7 mm (Fig. 2). Four pairs of epipodial tentacles. Snout large (by comparison with that of *U. vestiarius*), tubular, with a short mid-ventral split; papillae on terminal part well developed (Fig. 3). Foot bifid anteriorly.

Remarks

U. eloiseae differs from *U. vestiarius*, the only other species of *Umbonium* recorded from the Indian Ocean, by its smaller size, lower spire, less developed umbilical callus, silky (not shiny) surface, less varied colour pattern (see Grüneberg 1980, for discussion of the polymorphism of *U. vestiarius s.l.*) and its dark reddish brown apical whorls. The external anatomy is also unusual. The short, symmetrical cephalic tentacles, the absence of eyes and the branch-like, left neck-lobe are features more like those found in the tribe Bankiviini than in the tribe Umboniini (Hickman & McLean 1990). *U. vestiarius* has not been found at Masirah Island. In Oman generally it has only been found in the warmer inshore waters of the Batina coast in the vicinity of Muscat.

Etymology: The new species is named after Eloise Bosch, whose name is already enshrined in that striking and equally localised mollusc from Sur Masirah, *Actaeon eloisae* Abbott, 1973.

ACKNOWLEDGEMENTS

We are grateful to Dr. D. T. Bosch for enabling us to visit the Sultanate of Oman to collect and study molluscs, and to him and his wife Eloise for their assistance and hospitality during our visit; to Mr. J. W. Creutzberg, Managing Director of KLM Oman, for kindly arranging a courtesy air ticket for one of us from Amsterdam to Seeb; and to all the members of our research team for their enthusiastic help. Dr. D. G. Reid and Ms Kathy Way (Natural History Museum, London) and Dr. H. Coomans (ZMA) examined some of our specimens and offered helpful advice. L. van der Laan (ZMA) was responsible for pictures 4–12; and the SEM pictures were made at the Laboratorium voor Elektronenmikroskopie, University of Amsterdam.

REFERENCES

- BIGGS, H. E. J., 1973. The marine Mollusca of the Trucial coast, Persian Gulf. *Bull. Br. Mus. nat. Hist. (Zool.)*. **24**: 343–421, 6 pls.
 BOSCH, D. & BOSCH, E., 1982. *Seashells of Oman*. Longman's, London, pp. 206, illust.
 FRETTER, V., 1975. *Umbonium vestiarius*, a filter-feeding trochid. *J. Zool. Lond.* **177**: 541–552.
 GRÜNEBERG, H., 1980. On pseudo-polymorphism. *Proc. R. Soc. Lond. B* **210**: 533–548.
 HICKMAN, C. S. & MCLEAN, J. H., 1990. Systematic revision and suprageneric classification of Trochacean gastropods. *Science Ser. nat. Hist. Mus. Los Angeles County* **35**: 1–169.
 SMYTHE, K., 1982. *Seashells of the Arabian Gulf*. Allen & Unwin, London, pp. 123, illust.

A NEW SPECIES OF MARGINELLID (GASTROPODA: PROSOBRANCHIA) FROM THE NORTH COAST OF BRAZIL

PAULINO J. S. DE SOUZA JR.¹

(Accepted for publication, 16th May, 1992)

Abstract: A new species of Marginellidae, tentatively referred to the genus *Prunum*, is described from the North coast of Brazil. The generic status of *Prunum* and related genera is discussed.

Resumo: Uma nova espécie de Marginellidae, alocada tentativamente no gênero *Prunum*, é descrita para costa norte do Brasil. A taxonomia a nível genérico é discutida.

Keywords: Marginellidae, Brazil, *Volvarina*

INTRODUCTION

This work deals with material from the north coast of Brazil, off the Pará and Amapá states (4°30'N to 1°30'S, 46°W to 51°30'W) collected by three oceanographic expeditions: N-NEI and N-NEII made by the NOAS respectively in 1967 and 1968 and the AMASSEDs project made by RVCi in 1990 (Fig. 1). In the N-NEI and N-NEII the samples were taken with a 120 litre rectangular dredge (Coutinho & Kempf 1972) and in the AMASSEDs the samples were taken with a box core.

Among this material were several specimens belonging to a species of Marginellidae as yet undescribed. This new species is tentatively referred herein to the genus *Prunum* Herrmannsen, 1852.

THE GENERA *VOLVARINA*, *PRUNUM* AND *EGOUENA*

The definition of the genera *Volvarina* Hinds, 1844, *Prunum* Herrmannsen, 1852 and *Egouena* Jousseaume, 1875 seems to be based in combinations of characters that are more or less present in all of these genera, rather than exclusive to any one. This situation makes the boundaries between them diffuse and thus leads to subjective taxonomic decisions. No attempt will be made here to solve this taxonomic problem, but as an introduction to the species discussion, a synthesis of their similarities and of the definitions currently in use (Coover 1988, 1990; Gofas 1989; Roth 1978) will be given.

All three genera share cylindrical to subovate shells with low to medium spires, columellar plaits (usually four) occupying less than half of the aperture, smooth inner lip even in adults, radula with large comb-like teeth, animal ("type 2" of Coover 1987) with mantle covering the shell when alive and undisturbed.

Volvarina Hinds, 1844 (type species *Marginella nitida* Hinds, 1844 (= *Voluta mitrella* Risso, 1826) from the Mediterranean, subsequent designation, Redfield 1871), comprises cylindrical to subovate shells with moderately elevated to low spires, rather small (5 to 20 mm),

¹ Depto. de Zoologia, Inst. de Biologia, CCS, UFRJ, Rio de Janeiro, 21941, Brazil.

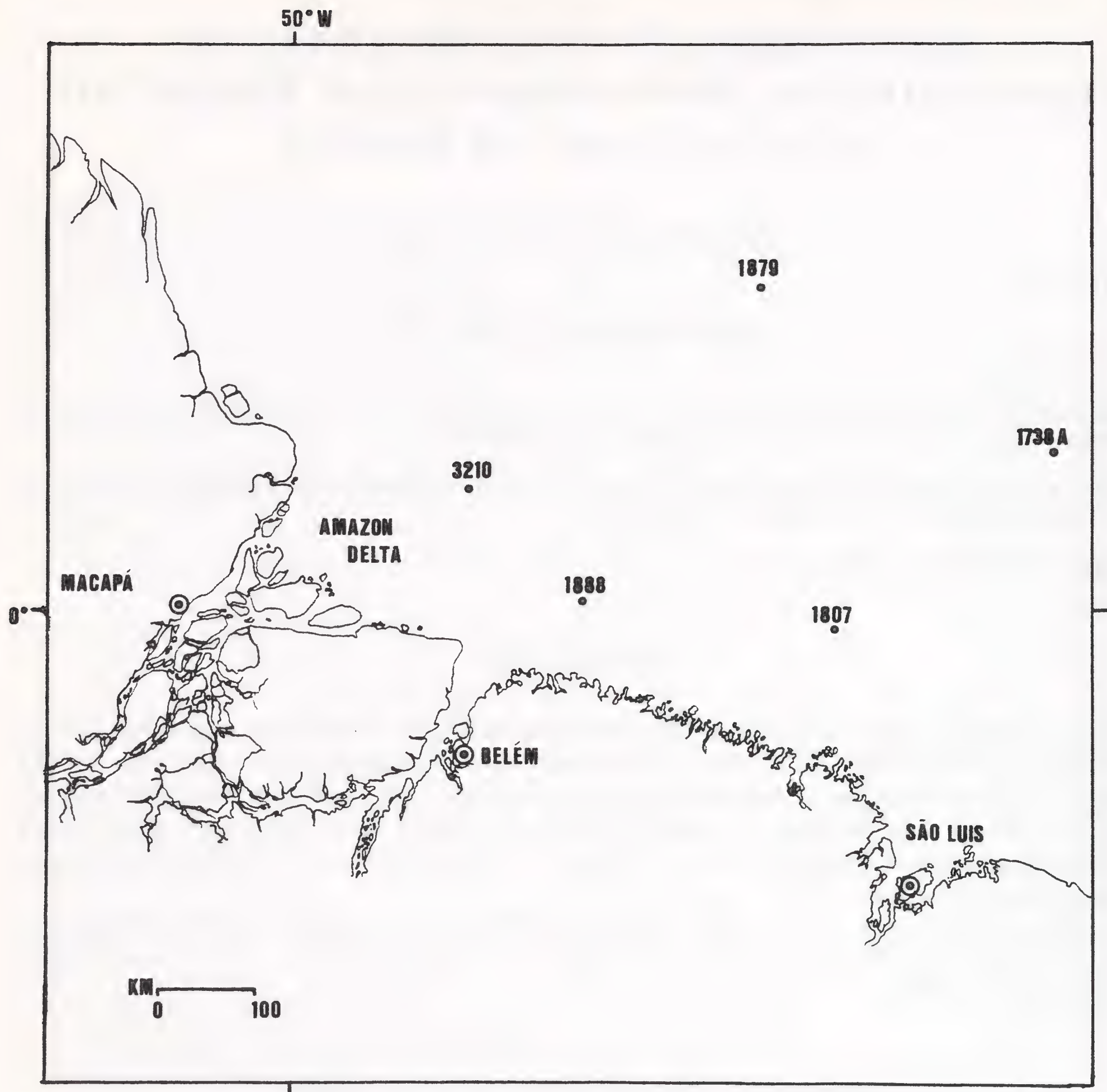


Fig. 1. Map of the Amapá and Pará coasts showing the collecting stations.

rarely showing an angular shoulder. In the type species, the outer lip is curled and thickened internally, without external varix. Callus deposition around the aperture is weak or absent. Colour pattern of spiral bands is often present. Coover (1988) restricts the use of *Volvarina* to species without external varix, whereas Gofas (1989) includes a wider array of small species with or without external varix.

Prunum Hermannssen, 1852 (type species *Voluta prunum* Gmelin, 1791, from the Caribbean region, original designation) (Roth 1978) includes rather large (10 to 40 mm) shells, ovate to elongate with medium to low spire, sometimes showing a shoulder marked by an angle. The outer lip is thickened, often forming a varix. There can be some callus deposition around the aperture and on the spire. Colour pattern, when present, consists of indistinct banding or irregular spotting (Coover 1988, Roth 1978). Redfield (1869) discussed the identity of the type species *Voluta prunum*, generally accepted as an American species and not the African *Prunum amygdalum* (Kiener, 1841) which has been confused with it in Gmelin's original description (Gmelin 1791).

DE SOUZA: A NEW SPECIES OF MARGINELLID FROM BRAZIL

Egouena Jousseaume, 1875 (type species *Egouena egouen*, by tautonymy, and subsequent designation by Tomlin, 1917) is considered a synonym of *Prunum* and distinguished from *Volvarina* by the same characters (Jousseaume 1875).

DESCRIPTION OF *PRUNUM AMPHORALE* n. sp.

Holotype Figs. 2–3: Shell very small for the genus (length 3.6 mm, width 1.8 mm), consisting of $3\frac{1}{2}$ whorls, elongated with body whorl narrowing anteriorly. Spire conical, rather high (apical angle 54°). Protoconch indistinct from teleoconch, obliquely flattened apically. Surface smooth, unsculptured, entirely covered by a shiny enamel. Sutures hardly distinct, the inner (“false”) suture more conspicuous.

Aperture narrow and elongate (aperture length 2.3 mm), parallel sided. Outer lip thickened forming a faint varix inwards and slightly sinuous, smooth inside. Posterior end of the outer lip flaring, anterior end curved and gradually merging into the columella. Posterior part of parietal wall slightly convex, covered by a transparent elongated callus. Columella straight with 6 folds, including the one at its base, the three most anterior oblique folds are subequal in size and much stronger than the posterior ones.

Colour pattern on the body whorl consisting of three indistinct orange brown spiral bands on a translucent creamy white background: one narrow band between suture and “false” suture, another broad band occupying almost $\frac{1}{3}$ of the body whorl, the third band very faint, located just behind of the anterior notch. Subsutural band also seen on the spire. Outer lip with three small blotches terminating the brown bands (Fig. 2).

Type Locality

Off Pará, Brazil, $01^\circ52'27''\text{N}$, $048^\circ16'12''\text{W}$, 47 m on sandy bottom.

Type Material

Holotype MORG 29379. Paratype 1 (Fig. 3), IBUFRJ 3084 (length: 3.6 mm; width: 1.7 mm). Paratype 2 USNM 860305 (length: 3.6 mm; width: 1.8 mm). Paratype 3, MNRJ 6205 (length: 3.6 mm; width: 1.8 mm). Paratype 4, BMNH 1992081 (length: 3.6 mm; width: 1.7 mm). Paratype 5, LACM 2259 (length: 4.0 mm; width: 2.0 mm). Paratype 6, MORG, 29380 (length: 3.3 mm; width: 1.7 mm). Paratype 7, IBUFRJ, 3085 (length: 3.3 mm; width: 1.7 mm). Paratype 8, IBUFRJ, 3086 (length: 3.3 mm; width: 1.6 mm). Paratype 9, MORG, 15299 (length: 3.8 mm; width: 1.8 mm). Paratype 10, MNHN (length: 4.0 mm; width: 1.8 mm).

Localities of referred material

One lot with one adult specimen collected on station 1738A ($01^\circ55'30''\text{N}$, $042^\circ45'\text{W}$, 75 m) on 31/10/1967 (paratype 5). One lot with one adult specimen collected on station 1807 ($00^\circ13'\text{S}$, $044^\circ46'\text{W}$, 54 m) by the NOAS on 26/11/1967 during the N-NE I (paratype 10). One lot with one adult specimen collected on station 1879 ($03^\circ04'\text{N}$, $045^\circ24'\text{W}$, 68 m) on 25/04/1968 (paratype 4). One lot with six adults specimens collected on station 1888 ($00^\circ12'\text{S}$, $047^\circ03'\text{W}$, 33 m) by the NOAS on 26/04/1968 during the N-NEII (paratypes 1–3 and 6–9). One lot with one adult specimen collected by the RVC I during the second leg of the third cruise of the AMASSEDS project, station 3210 ($01^\circ52'27''\text{N}$, $48^\circ16'12''\text{W}$, 47 m) (holotype).

DISCUSSION

The choice of placing this species in *Prunum* rather than other genera is guided by the following characters: (1) the general outline of the shell which is rather biconic and thus



Fig. 2. *Prunum amphorale* n. sp., holotype, actual length 3.6 mm.

Fig. 3. *Prunum amphorale* n. sp., Scanning electron micrograph of paratype 1, actual length 3.6 mm.

forms an angular shoulder; this outline is present in many species assigned to this genus, including the type species (e.g. *Prunum succinea*, (Conrad, 1846), *P. godini* Olsson, 1964, *P. gorgonense*, Roth, 1978). In *Volvarina* the outline is generally more evenly curved with no angulation at the shoulder. (2) the varix of the outer lip, although weak, is clearly developed; in *Volvarina* the thickening is mostly internal.

"*Marginella*" *perexilis* Bavay, 1922 is the most closely allied species. I have studied 6 syntypes in MNHN from Paraiba, Brazil, which differ in being much smaller (ca. 2 mm), in having a more cylindrical spire, a less angulated shoulder, and the posterior end of the outer lip not so much projecting as it is in *P. amphorale*. Both species present a characteristic that departs from all genera mentioned above, and from most marginellid genera, which is the number of columellar plications (6). It is quite likely that these two species are congeneric and that a new genus will be needed, but a provisional generic allocation is more prudent until data on the living animals and their radula are available.

P. amphorale differs from any other western Atlantic *Prunum*-like species by its small size. *P. succinea* is similar in outline, but *P. amphorale* differs in the banded colour pattern, the coloured markings on the outer lip, the narrower anterior end and the columellar folds. *Volvarina pauli* Jong & Coomans, 1988, is slightly larger (4 mm), has a blunter apex due to a larger protoconch, the spire is lower and the shoulder is not angular, and has only four

columellar plaits. “*Volvarina*” *abbotti* Jong & Coomans, 1988, departs from the definition of the genus in having eight columellar folds, and its generic position is also considered provisional. It differs from *P. amphorale* in being larger (5.5 mm) with a much lower spire and in lacking a definite shoulder; the anterior part of the aperture is broader and the outer lip insertion is much closer to the apex than in *P. amphorale*.

There was some intraspecific variation in this species. Paratypes 5 and 9 have a fainter banding on a white (instead of creamy) background. In some shells (holotype, paratypes 1, 2, 4, 5, 6) the protoconch seemed to be a bit flattened obliquely to the longitudinal axis, whereas others have a perfectly rounded apex. Nevertheless, the number and patterns of columellar folds are absolutely regular in all shells.

Etymology: *amphorale* (latin) having the quality of an amphora, in reference to its shape.

ABBREVIATIONS

NNEI: Norte Nordeste I Oceanographic Commission.
 NNEII: Norte Nordeste II Oceanographic Commission.
 NOAS: Navio Oceanográfico Almirante Saldanha.
 AMASSEDs: A Multidisciplinary Amazon Shelf SEDiment Study.
 RVCI: Research Vessel Columbus Iselin.
 MORG: Museu Oceanográfico do Rio Grande.
 IBUFRJ: Instituto de Biologia da Universidade Federal do Rio de Janeiro.
 USNM: National Museum of Natural History, Washington D.C.
 MNRJ: Museu Nacional do Rio de Janeiro.
 BNHM, British Natural History Museum.
 LACM: Natural History Museum of Los Angeles County.
 MNHN: Muséum National d’Histoire Naturelle, Paris.

ACKNOWLEDGEMENTS

I am grateful to Renato L. Cruz, Dr. Ricardo S. Absalão, Dr. Eliézer C. Rios and Dr. Serge Gofas for assistance of various kinds during this work. I am also thankful to my father who helped me with the photography. Finally, helpful criticism on the manuscript was given by Flávio Bockmann and Marcelo Carvalho.

REFERENCES

- COOVERT, G. A., 1987. A literature review and summary of marginellid external anatomy. *Marginella Marginalia* **3** (2/3): 8–25.
 —, 1988. Marginellidae of Florida, Part II: *Prunum succinea* with discussion of *Prunum* and *Volvarina*. *Marginella Marginalia* **4** (5): 35–41.
 —, 1989. A literature review and summary of published marginellid radulae. *Marginella Marginalia* **7** (1–6): 1–37.
 —, 1990. A study of marginellid radulae Part I: Type 6 Radula, *Prunum/Volvarina* Type. *Marginella Marginalia* **8–9** (1–6): 1–68.
 COUTINHO, P. N. & KEMPF, M., 1972. Plataforma Continental do Norte, Nordeste e Leste do Brasil: Amostras de fundo coletadas pelo NOc. Almirante Saldanha em 1968. *Trab. Oceanogr. Univ. Fed. Pernambuco* **13**: 29–40.
 GOFAS, S., 1989. Le Genre *Volvarina* (Marginellidae) dans la Méditerranée et l’Atlantique du Nord-Est. *Boll. Malacol.* **25** (5–8): 159–182.

- GMELIN, J. F., 1791. Caroli a Linné Systema Naturae per Regna Tria Naturae. Editio Decima Tertia, aucta, reformata. **1**, pt. 6, cl. 6, Vermes: 3021–3910.
- JOUSSEAUME, F. P., 1875. Coquilles de la famille des Marginelles. *Rev. Mag. Zool.* (3) **3**: 164–271 and 429–435, pl. 7–8.
- REDFIELD, J. R., 1869. Notes upon the monograph of the genus *Marginella* in Reeve's *Conchologia iconica*. *Amer. J. Conch.* **5** (2): 88–95
- ROTH, B., 1978. New species and records of Tropical West American Marginellidae (Mollusca: Neogastropoda). *Contrib. Sci. Nat. Hist. Mus. Los Angeles County* **292**: 1–18.

OBITUARIES

KATHLEEN ROSEMARY SMYTHE

(14 June 1923—30 June 1991)

Kathleen Smythe, a member of the Conchological Society since 1965, was a most enthusiastic and intrepid collector of marine shells who specialized in the fauna of the Gulf and was a leading authority on marine molluscs of that region which she visited many times. Her energy was amazing and also her fortitude in the face of severe illness which she battled against for over 15 years. To all who knew her she was a person to be remembered.

Kathleen Smythe was born at Kolar Goldfields, Mysore State, southern India where her father was a mining engineer. She was sent to school in England and went on to read History at Royal Holloway College, University of London but because of wartime conditions she opted to leave College and join the WRNS where she served as an air mechanic to the Fleet Air Arm in Fife, Scotland. After the war she returned to India where she taught, married (in 1948) and where her only son Peter was born. Her husband Bill Smythe, also a mining



Kathleen Smythe working on the Melville-Tomlin Collection in the National Museum of Wales, Cardiff. Circa 1975. Phot: J. Chatfield.

engineer, was from Cornwall and son of the veterinary surgeon and author R. H. Smythe. Kathie Smythe had a particular affection for her husband's county of Cornwall, and the surname of Smythe is a Cornish one.

The family went to Tanganyika in East Africa and travelled considerably since Bill Smythe was Inspector of Mines, and there they made many lifelong friends. Holidays were spent on the east coast of Africa and it was here that Kathie Smythe developed her interest in marine Indo-Pacific molluscs and made a shell collection. During their home leave to England she used the facilities of the library and collections of the British Museum (Natural History) to identify east African shells, and that was where I first met her in the early 1960s. She joined the Conchological Society of Great Britain and Ireland in 1965 and later the Malacological Society of London. Tanzania came under Communist rule and they left Africa in the mid 1960s, returned to England and began to prepare for a new future in Australia. This was not to be, for Bill Smythe died suddenly of a coronary in 1965.

Now, permanently based at Aldwick, Bognor Regis in West Sussex, Kathie Smythe took up various employments and was with the DHSS in legal aid and as Fraud Officer. All her spare time was devoted to shells and there were opportunities to make visits overseas since a number of friends from East Africa days were posted in Arabia. Thence began her long association with the molluscs of the Gulf in which she built up much experience in the field and became a well known authority. This interest in Arabian molluscs started when the Rev H. E. J. Biggs was alive – he gave her the benefit of his experience and knowledge of the literature of this rather special area of enclosed sea and varying salinity. On the death of H. E. J. Biggs in 1973, Kathie Smythe was responsible for the sale of his library to Society members and she acquired some items for her own studies, taking over from Biggs as the conchological expert in the Gulf. Through a colleague at work, she had been put in touch with Major Michael Gallagher, then with the British Army in the Gulf (Bahrain and Sharjah from 1971) who had a general interest in natural history and helped to collect molluscs. During the 1970s, visits followed to Bahrain, Kuwait, eastern Saudi Arabia, the United Arab Emirates, Iran (working from the University of Tehran with Professor Tejali Pour and making an expedition to the Island of Hormuz) and from 1980–1988 to Oman. M. D. Gallagher, having retired from the Army, went on contract to the Ministry of National Heritage and Culture of the Sultanate of Oman where he was involved in the Oman Flora and Fauna Survey on Jabal Akhdar and for which Kathie Smythe reported on the terrestrial molluscs of this nature reserve. In 1977 she reported on the seashells collected at Dhofar and was invited to Oman which was visited almost annually from 1980–1988, during this time setting up a National Shell Collection and involved in a mollusc display at the new Natural History Museum in Muscat. She also studied and wrote a book on the molluscs of the nature reserve at Qurm Creek and undertook survey work on the Island of Masirah off the coast of mainland Oman, which she visited with Dr. Donald Bosch, an American Medical Officer in the hospital there who was also interested in conchology.

Kathleen Smythe's scientific papers were largely of a faunistic nature with check lists of species for specific areas in the Gulf (Smythe 1972, 1975, 1977, 1979 and 1982) but other papers concentrated on individual groups – *Salinator* (Smythe 1975a & b), Tornatinidae and Retusidae (Smythe 1979) and *Fusinus (Sinistralia)* (Smythe & Chatfield 1981, Chatfield & Smythe 1982, Smythe & Chatfield 1984). Collecting a good deal in the field in many locations she was able to make observations on the animals in their natural habitat and took many photographs *in situ*. In the course of this work new species were described and these are listed below. Kathleen Smythe has three books to her name – *Seashells of the Arabian Gulf* (1982), as Editor of *Seashells of Oman* by Donald and Eloise Bosch (1982) and *Seashells of the Sultan Quabos Nature Reserve at Qurm* (1983) which was also printed in Arabic. Further books were planned, including a new much expanded version of *Seashells of Oman* in joint authorship with Donald Bosch, but this work was prevented by ill health.

OBITUARIES

Those of us who knew Kathie Smythe will be aware of the immense health problems which she courageously lived with during her most creative time writing papers and books on molluscs of the Gulf in the 1970s and 1980s. In the mid-1970s, being aware of a one-sided sore throat she sought medical advice as a side issue when collecting her hay fever prescription. This was diagnosed as malignant, an operation made immediately followed by radiotherapy. Whilst the cancerous growth was successfully brought under control, scar tissue developed making swallowing difficult – hence a liquid diet for about 15 years and non-functioning of the salivary glands for some years. Radiotherapy also affected tissue in the jaw which led to painful abscesses necessitating further major surgery when a piece of jaw bone was removed. Whilst in hospital following this operation Kathie Smythe was busy, complete with card indexes, files, books and even shells, working on her molluscs. Copies of *Seashells of the Arabian Gulf* were brought to her in hospital by the publishers Allen and Unwin. Her surgeon was most impressed by this positive attitude to her stay in hospital – time to be used, not wasted! Kathie Smythe had immense energy and following from most of her life spent in the tropics, she was up working very early in the morning and had usually accomplished a good two to three hours of mollusc work before normal breakfast time.

An attempt was made to graft a new piece of bone to the jaw, but this was not successful and the graft rejected and whilst it was being removed, Kathie suffered her first stroke under the operation and wrote little after this time. Over the next few years she had several strokes which affected her speech and use of right arm, but she showed an amazing ability to recover. Her deep interest in molluscs and many onward-going projects kept up her spirits and determination to keep going. She died in hospital in Chichester on 30 June 1991 following a stroke from which she never regained consciousness.

Although an earnest worker, she was a very sociable person, had a good sense of fun and humour, a wide range of interests (she once painted in oils) and a large circle of friends – from her days in east Africa, local natural history societies and many malacological contacts both professional and amateur from all over the world. It is unfortunate that ill health prevented completion of her work. Part of her collection was given to the Natural History Museum in 1990 and it was her wish that the rest should join this. With the recent Gulf war causing such widespread destruction to the environment, the baseline data of molluscs in the collections and publications of Kathleen Smythe have a valuable part to play in the assessment of this effect.

NEW SPECIES DESCRIBED BY K. R. SMYTHE

- Retusa tarutana* Smythe, 1979
- Bullia rogersi* Smythe & Chatfield, 1981
- Fusinus (Sinistralia) gallagheri* Smythe & Chatfield, 1981
- Fusinus (Sinistralia) somaliensis* Smythe & Chatfield, 1984
- Favartia (Favartia) paulboschi* Smythe & Hourt, 1984
- Latirus bonnieae* Smythe, 1985
- Costoanachis rassierensis* Smythe, 1985
- Anachis raysutana* Smythe, 1985
- Trochita dhofarensis* Taylor & Smythe, 1985
- Muricopsis omanensis* Smythe & Oliver, 1986
- Medusafissurella gallagheri* Smythe, 1988

- SMYTHE, K. R., 1972. Marine Mollusca from Bahrain Island, Persian Gulf. *J. Conch., Lond.* **27**, 491–496.
- SMYTHE, K. R. & PHILLIPS, W. W. A., 1972. Some observations on the fauna of the Maldiv Islands (Indian Ocean) Part VIII Marine shells. *J. Bombay nat. Hist. Soc.* **69**, 290–296.
- GOODCHILD, M. & SMYTHE, K. R., 1975. Mollusca. In: RAYNER, R. W., 1975. *The Natural History of Pagham Harbour. Part II Plants and Animals other than Birds and Mammals*. The Bognor Regis Natural History Society. pp. 54–58.
- SMYTHE, K. R., 1975. On the occurrence of *Salinator fragilis* (Lamarck) in the Arabian Gulf. *J. Conch., Lond.* **28**, 335–338.
- SMYTHE, K. R., 1975. *Salinator fragilis* (Lamarck) – habitat and behaviour. *J. Conch., Lond.* **28**, 339–342.
- SMYTHE, K. R., 1979. The Marine Mollusca of the United Arab Emirates, Arabian Gulf. *J. Conch., Lond.* **30**, 57–80.
- SMYTHE, K. R., 1979. The Tornatinidae and Retusidae of the Arabian Gulf. *J. Conch., Lond.* **30**, 93–98.
- SMYTHE, K. R. & CHATFIELD, J. E., 1981. New species of *Fusinus* (*Sinistralia*) and *Bullia* from Masirah, Oman. *J. Conch., Lond.* **30**, 373–377.
- CHATFIELD, J. E. & SMYTHE, K. R., 1982. Living specimens of *Fusinus* (*Sinistralia*) *gallagheri* Smythe and Chatfield 1981 from Masirah, Oman. *J. Conch., Lond.* **31**, 95–99.
- SMYTHE, K. R., 1982. Seashells of the Arabian Gulf. Allen and Unwin.
- SMYTHE, K. R. (ed.), 1982. BOSCH, D. & E. *Seashells of Oman*. Longmans.
- SMYTHE, K. R., 1983. Seashells of the Sultan Qaboos Nature Reserve at Qurm. Adviser for Conservation of the Environment Diwan of Royal Court Affairs, Muscat, Sultanate of Oman. Also in Arabic.
- SMYTHE, K. R. & CHATFIELD, J. E., 1984. *Fusinus* (*Sinistralia*) *somaliensis*: A new species of whelk from Mogadiscio, Somalia. *J. Conch., Lond.* **31**, 307–310.
- GLAYZER, B. A., GLAZER, D. T. & SMYTHE, K. R., 1984. The marine Mollusca of Kuwait, Arabian Gulf. *J. Conch., Lond.* **31**, 311–330.
- SMYTHE, K. R. & HOUT, R., 1984. *Favartia* (*Favartia*) *paulboschi*: a new muricid from Oman. *Informations de la Société Belge de Malacologie*. Ser. 12, 1:5–8.
- SMYTHE, K. R., 1985. Three new buccinids from Oman and notes on *Anachis fauroti* (Jousseaume) (Prosobranchia: Buccinacea). *J. Conch., Lond.* **32**, 23–35.
- TAYLOR, J. D. & SMYTHE, K. R., 1985. A new species of *Trochita* (Gastropoda: Calyptraeidae) from Oman: a relict distribution and association with upwelling areas. *J. Conch., Lond.* **32**, 39–48.
- SMYTHE, K. R. & OLIVER, P. G., 1986. A new species of *Muricopsis* from Oman (Prosobranchia: Muricacea). *J. Conch., Lond.* **32**:181–183.
- SMYTHE, K. R., 1988. A new species of *Medusafissurella* (Gastropoda: Fissurellidae), a keyhole limpet from Oman. *J. Conch., Lond.* **33**, 97–101.

JUNE CHATFIELD.

GORDON OSBORN FLS (1913—1991)

Many members will remember Gordon Osborn from Olney, Bucks who regularly attended indoor meetings of the Society in the 1960s and 1970s and, together with the Northamptonshire Natural History Society, hosted joint symposia in the Humfreys Rooms in Northampton, ending with splendid buffet suppers in the evening. On a number of occasions he gave talks at indoor meetings of the Conchological Society in the Natural History Museum.

Gordon Osborn was born in 1913 at Olney where his father was a butcher and, being brought up in a country town, developed an early interest in natural history, rocks and fossils and an avid appetite for books on the subject. From school he was apprenticed to train as a master butcher and was destined to take over the Osborn butchery businesses in Olney that had originated from retail outlets of a family farm, his younger brother Clive Osborn taking over the farming side. During World War II he was Captain in the fire service and some photographs of him in uniform are published in his book of photographs of the town. This period of his working life involved long hours, but natural history was not forgotten and Gordon Osborn was an active member of the Northamptonshire Natural History Society serving as President (1955–1957). His first wife Dora died in 1972 and during her long illness

he interested her in the setting up of a collection of sands that is now in the rooms of the Northamptonshire Natural History Society, the cabinet being donated and inscribed in memory of Dora. It is now the largest collection of sands in the country, with over 3,000 samples from all over the world.

Appointing a manager to run the business, Gordon Osborn took an early semi-retirement, devoting his time to many interests and activities – adult education teaching in geology with the WEA, studies of shells and fossils with the Conchological Society of Great Britain and Ireland, the Northamptonshire Natural History Society, The Milton Keynes Natural History Society, the Geologists' Association, the Palaeontological Association and the Linnean Society of London of which he was a Fellow. At the time of his death he was President of the Milton Keynes Natural History Society and President of the Olney Archaeological Society. He served on the Council of the Conchological Society and although he did not publish in the journal, he actively contributed to the mapping scheme of non-marine Mollusca making a tetrad survey of Northamptonshire published in co-authorship with M. Wallis and J. Pirie, members of the Northamptonshire Natural History Society. He was an Honorary Member of the British Shell Collectors' Club performing the role of judges' steward at many of their annual shell shows. In the geological field he was a member of the Palaeontological Association and member of the Geologists' Association.

During retirement, he not only wrote, but published a number of books himself – *Cowper Country* (1976), a reprint of the *Olney Hymns* (1979), *A Handbook of Sand* (1984) and *The Building Stones of Central Northampton* (1989). With R. A. Martin he also wrote a guide to the geology of Northamptonshire (1976) and with J. Pirie and M. Wallis *A Report on the Land and Freshwater Mollusca of Northamptonshire* (1985). With Elizabeth Knight he wrote *Olney and District in Camera* (1987) and *Around Olney in Camera* (1988). At the time of his death he was compiling recollections of the butchery trade, tools and practises no longer in use and his memoirs. It is hoped that this will be published posthumously.

Gordon Osborn collected oysters and had the finest collection in private hands. He was a recorder of mosquitoes for Northamptonshire and also collected fleas.

As well as being active in adult education and in the running of societies, Gordon Osborn was interested in museums and as Chairman of the Trustees was instrumental in raising substantial grant aid for the buildings and collection care at the Cowper and Newton Museum in Olney.

Among the outstanding qualities of Gordon Osborn were his enthusiasm, kindly manner, positive approach, great patience with beginners and in encouraging and helping young people to take an interest in natural history and geology. He believed in a serious hard-working approach and getting the boots dirty in field work – but that was not to preclude enjoyment – rather than a casual dilettante interest, and he always had specific projects of his own in progress.

In 1985 he married Patricia and together they took an active part in the Northamptonshire Natural History Society and especially in curating the collections of minerals and shells at the Humfrey Rooms, which, under Gordon's leadership had developed to include not only the original lecture room, book cases and cabinets, but also an extension with a fully equipped laboratory and microscopes. His involvement with that society will be covered in greater detail in a forthcoming obituary by T. Pain in their journal.

The last ten years of his life were limited by ill-health, particularly heart attacks which prevented further attendance of London meetings. He died on 31 December 1991.

I am grateful to Patricia Osborn and Tom Pain for their additions and corrections to the text.

JUNE CHATFIELD

PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

REPORT OF THE COUNCIL, 1991–1992

The Society announced with regret the deaths of three members: Mrs. K. R. Smythe who joined in 1965, Mr. A. G. H. Osborn, a member since 1973 and Mr. L. Cram who joined in 1990.

There have been several changes of the Society's Officers in the last year: Mrs. E. B. Rands stood down as Acting Hon. Secretary and Mrs. Susan Davies was appointed by Council to act as Hon. Secretary until the 1992 AGM. Mr. P. E. Negus retired from the post of Newsletter Editor after 25 years service.

At the 1991 AGM Mrs. J. M. Light was elected as Hon. Recorder for marine Mollusca and Dr. R. C. Preece as Hon. Editor, *Journal of Conchology*. Dr. B. F. Coles, Mr. D. R. Seaward and Dr. E. E. Sandor were all elected to serve on Council for 3 years; Mr. P. Lee and Mr. E. G. Philp were both elected on to Council for 1 year. Mr. D. G. Guntrip was co-opted to Council as Minutes Secretary.

The Society's membership for Ordinary, Family, Student, Life, Honorary and Institutional categories stands at 450. There are a further 144 subscribers to the *Journal of Conchology*. New memberships included 14 full, 1 family and 2 subscribers.

In 1991 the Society issued the following publications: 2 parts of the *Journal of Conchology*, 4 parts of the *Conchologists' Newsletter* with an Index to Numbers 101–120 and *Paper for Students* No. **20**: Keeping a marine aquarium. A copy of the amended Rules of the Society was distributed to all members.

During the year, Council more clearly defined the composition and role of the Publications sub-committee. A much greater degree of responsibility for all aspects of producing publications was devolved to it. Council also recognized the need for a publicity and membership drive.

Susan Davies
(Honorary Secretary)

PROGRAMME SECRETARY'S REPORT

The 1991 programme comprised 8 indoor meetings held at the Natural History Museum, 9 field meetings and a molluscan workshop.

At the indoor meetings lectures were given by Dr. John Baxter (NCC Scotland), Mr. Peter Walker (MAFF Lowestoft), Mrs. Marjorie Fogan, Dr. Brian Eversham (Biological Records Centre, Monks Wood), Mr. Noel Gregory, Dr. Rupert Honnor, and Dr. Martin Willing. An open meeting with a conchological quiz was held in December. The Society extends its thanks to all of the above speakers.

The seventh Molluscan Workshop was held at Godalming in November. This year the Workshop was expanded to cover all British molluscs, marine and non-marine. This format attracted new Members and will be repeated again, in 1992. We are grateful to Mrs. Jan Light for making her home available for this event.

Field meetings were held around the country at the following localities: Pope's and

Saltridge Woods, Gloucestershire; Whitecliff Bay, I.W.; southern Cumbria; Weymouth, Dorset; south-east Suffolk; West Runton, Norfolk; Pevensey, Sussex; Porlock, Devon and Burnham Beeches, Bucks. All of these meetings were successful and well attended. Thanks are due to the leaders: Mr. David Long, Mrs. Jan Light, Dr. Barry Colville, Mr. Bill Pocock, Mr. Philip Cambridge, Mr. Derek Howlett, Mr. Phil' Palmer, and Dr. June Chatfield.

I. J. Killeen
(Programme Secretary)

TREASURER'S REPORT, 1991

The accounts for the year ended 31 December 1991 show an excess of income over expenditure of £4,437 (1990: £2,056) and a profit for the year after transfers to reserves of £2,416 (1990: £85). This is principally due to the increase in subscriptions and the change in

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1991

INCOME AND EXPENDITURE ACCOUNT

	31.12.91 £	31.12.90 £
INCOME		
Fees and subscriptions	12,403	10,612
Investment Income	4,033	3,852
Sales/Donations	542	394
Sundry	40	45
	17,018	14,903
EXPENDITURE		
Publication costs	9,955	9,421
Stationary and postage	1,457	2,181
Members' list	—	500
Meetings	420	480
Sundry	749	265
	(12,581)	(12,847)
Excess of income over expenditure	4,437	2,056
Transfer to publicity reserve	(400)	(400)
Transfer (to)/from Reserves:		
Reserve and Research fund	(807)	(771)
Life Members' Fund	(814)	(800)
Profit for the year	2,416	85

PROCEEDINGS

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN & IRELAND
ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1991

BALANCE SHEET

	31.12.91 £	31.12.90 £
ASSETS		
Investments	17,663	17,663
Cash	15,154	6,978
Debtors	1,287	
	34,104	24,641
LIABILITIES		
Creditors and accrued charges	4,187	815
Advance subscriptions	2,601	924
Life members' fund	4,614	3,800
Reserve and research fund	4,554	3,747
Publicity reserve	800	400
	16,756	9,686
	17,348	14,955
Represented by:		
Capital account brought forward	14,955	14,870
Profit for the year	2,416	85
	17,371	14,955

A. D. Seccombe ACA
Honorary Treasurer

A. N. Light FCA
D. Worth
Honorary Auditors

the way tax has been recovered on deeds of covenants. Up until this year tax was recovered at 31 December for all investment income received net of basic rate tax and subscriptions paid under deed of covenant in the 12 months to the previous 5 April. This year tax has been reclaimed on investment income and subscriptions received under deed of covenant in the period 6 April 1990 to 31 December 1991 (21 months). This approach is permitted by the inland revenue. The result is that tax reclaimed amounts in total to £1,170 (1990: £744). The amount of tax reclaimed in 1992 will revert to that arising in a 12 month period.

Income from subscriptions from ordinary members increased by £1,005 and income from subscribers and institutional members by £696 reflecting the increase in subscriptions rates.

Publication costs increased by £534. However this was principally caused by a print run of the covers for the *Journal of Conchology* which cost £1,016. The costs of producing the

Newsletter are still falling at £3,052 (1990: £3,901). It is intended that during 1992 the printing of the *Newsletter* will be carried out by a different printer in a revised format resulting in considerable savings to the Society. The costs of the *Journal* increased to £5,540 (1990: £4,906) As a result of vol 34 No. 2 which was a particularly large issue.

Bank charges for the year amounted to £140 (1990: £89). The treasurer is researching alternatives to the existing arrangements as it is considered unacceptable that the Society, which is a registered charity, should have to pay bank charges.

As in 1990, £400 has been put aside for the publicity drive which appears to be gathering momentum. The treasurer also sought council's permission to purchase a microcomputer to facilitate the job of the Secretary and to enable the labels for the *Newsletter* and *Journal* to be printed more efficiently. The computer which will be compatible with machines owned by a number of the officers of the Society will cost in the region of £1,000. It will be used by the Honorary Secretary but will at all times remain the property of the Society.

Subscription rates will be held at their current levels for 1992. It is hoped that the reduction in the cost of producing the *Newsletter* will ensure that the subscription rate will not need to be increased until 1994.

A. D. Seccombe
(Honorary Treasurer)

RECORDER'S REPORT: MARINE MOLLUSCA

Further to my note in the *Conchologists' Newsletter* no. **119** (December 1991) regarding the occurrence of *Paludinella litorina* (delle Chiaje) at Martinhoe in Devon, I am pleased to report that this species has now been located at Whitecliff Bay on the Isle of Wight. This reaffirms the 1853 record for this species (Forbes & Hanley, Vol. **IV**, p. 266). Another old record (Morey, F., 1909, *A guide to the natural history of the Isle of Wight*, p. 265) has been reaffirmed at Kings Quay on the Isle of Wight with the finding of a colony of *Truncatella subcylindrica*, a second site for the living animal on the Island and the fifth in southern England.

Thanks are due to all those who submitted records particularly Ian Killeen, Julia Nunn and Shelagh Smith. Adults and eggs of the nudibranch *Catriona gymnota* (Couthouy) were observed on the hull of a boat moored in the River Medina, Isle of Wight by Roger Herbert, and identified by Bernard Picton. This is new for S15 and an extension of range from S18.

During 1991 access to material collected offshore has been made possible by various organisations including MAFF: Solent Oyster Survey (June), English Channel Scallop Survey (July) and Young Flatfish Survey (September). The School of Ocean Sciences at the University of Bangor, Menai Bridge carried out survey work for MAFF in the Celtic Sea and benthic samples were collected on our behalf. All of the above samples have been processed and yielded many new and updated sea area records.

A major survey of the Southern Irish Sea has been carried out by the National Museum of Wales, Cardiff. Material is still being analysed but preliminary results also show a large number of new live sea area records.

Cooperation with other organisations is much valued and thanks should go to the following: Dennis Key, Peter Walker, Colin Whiting all of MAFF and Matt Richmond for the Celtic Sea material.

In addition to acknowledging the assistance of those mentioned in this report I would like to thank my predecessor Dennis Seaward for valued advice and support during my first year in office.

Jan Light

PROCEEDINGS

RECORDER'S REPORT: NON-MARINE MOLLUSCA

A. Mapping schemes

The publication shortly by Harley Books of a new edition of the national *Atlas* has generated a flurry of activity in local mapping, including tetrad mapping. Not only has this helped to fill many gaps in the national coverage at 10-km square level, but is reflected in an unusually large number of new vice-comital records, detailed below.

B. Vice-comital records

The following new records have been authenticated since the last Report (*J. Conch., Lond.* **34**, p. 112). The collection date was in all cases 1991–2, unless stated to the contrary.

- Cornwall East (2): *Cochlodina laminata*, Greystone Wood, Lezant (20/3678), K. N. A. Alexander.
- Devon North (4): *Valvata cristata*, Knowstone (21/8223), D. E. Bolton; *Hygromia cinctella*, Bideford (21/4526), D. E. Bolton and G. Musker; *Hygromia limbata*, West Down (21/5042), D. E. Bolton and B. J. Meloy.
- Somerset North (6): *Hygromia cinctella*, Yatton (31/4365; garden), Mrs. F. Moulin.
- Hants South (11): *Cochlicella acuta*, Wymering (41/6405), R. Hollins.
- Bucks (24): *Lymnaea glabra*, Aylesbury (42/81), F. Taylor, c. 1900, Stoke-on-Trent Museum; *Ferrissia wautieri*, Hythe End (51/0172), Ms. M. Whitfield; *Boettgerilla pallens*, Burnham Beeches (41/9484), Dr. June Chatfield, 1988.
- Suffolk East (25): *Arion fasciatus*, Felixstowe (62/2935), I. J. Killeen, 1989.
- Gloucester West (34): *Helicodiscus singleyanus*, Fretherne (32/7209; tidal debris), C. R. C. Paul; *Pisidium supinum*, Oxenhall (32/7127; old shell), Ms. S. Rowlatt.
- Salop (40): *Acicula fusca*, *Vertigo antivertigo*, Trefonen (33/2426); *Vertigo lilljeborgi*, Sweeney Fen (33/2725), all R. A. D. Cameron.
- Carmarthen (44): *Planorbis carinatus*, Llanelly (22/5301); *Acroloxus lacustris*, Aberegwili (22/4520), 1990, both I. K. Morgan.
- Caernarvon (49): *Arion flagellus*, Pwllheli (23/4037), D. Bilton.
- Flint (51): *Planorbarius corneus*, Tremeirchion (33/0771; garden pond), Mrs. N. F. McMillan.
- Lincoln South (53): *Vertigo antivertigo*, Thurlby Fen (53/1216), J. H. Bratton.
- Nottingham (56): *Zonitoides excavatus*, Edwinstowe (43/6267), B. Colville.
- York Mid-west (64): *Pisidium tenuilineatum*, R. Wharfe, Grassington (34/9963), J. Bass, 1990.
- Cumberland (70): *Physa acuta*, R. Eden, Carlisle (35/4356); *Trichia plebeia*, Carlisle (35/3856), both S. P. Dance; *Arion owenii*, Carlisle (35/3858), D. Bilton; *Limax maculatus*, Kirkbride (35/2256), Dr. Shelagh Smith, 1988.
- Dumfries (72): *Boettgerilla pallens*, Moffat (36/0805), A. T. Sumner.
- Ayr (75): *Boettgerilla pallens*, Maybole (26/3009), A. T. Sumner.
- Renfrew (76): *Arion flagellus*, *Arion owenii*, *Boettgerilla pallens*, Barrhead (26/5059), A. T. Sumner.
- Lanark (77): *Arion owenii*, *Boettgerilla pallens*, Drumgelloch (26/7765), A. T. Sumner.
- Edinburgh (83): *Cecilioides acicula*, Holyrood Park (36/2772), Ms. D. Rankin.
- Stirling (86): *Lymnaea stagnalis*, *Planorbarius corneus*, Forth & Clyde Canal, Falkirk (26/8780), T. Huxley, 1990.
- Perth West (87): *Boettgerilla pallens*, Dunblane (27/7701), A. T. Sumner.
- Forfar (90): *Ovatella myosotis*, Montrose Basin (37/6859); *Vallonia costata*, *Vallonia excentrica*, Monifieth (37/4932); *Pisidium amnicum*, Balgavies Loch (37/5350), all T. Huxley, 1989–90.
- Banff (94): *Limax tenellus*, Aberlour (38/2542), A. T. Sumner.
- Easternness (96): *Arion flagellus*, Upper Lenie (28/5127), S. M. Davies.

Main Argyll (98): *Arion flagellus*, *Arion owenii*, *Boettgerilla pallens*, *Limax maculatus*, Oban (17/8529), A. T. Sumner; *Deroceras agreste*, Glen Coe (27/25), S. M. Davies.
 Dunbarton (99): *Arion flagellus*, *Arion owenii*, *Deroceras caruanae*, Helensburgh (26/2883), A. T. Sumner; *Boettgerilla pallens*, *Limax flavus*, Helensburgh (26/2982), S. M. Davies.
 Ross East (106): *Potamopyrgus jenkinsi*, Talich (28/8578), T. Huxley, 1990.
 Limerick (H8): *Assiminea grayana*, R. Maigue, Ferry Bridge (11/4852), B. Colville.
 Clare (H9): *Assiminea grayana*, R. Fergus, Clare Castle (11/3574), B. Colville.

Several of the above are worthy of note. *Vertigo lilljeborgi* from a Shropshire fen is the first English record of this highland zone species south of the Lake District, and complements the half-dozen or so scattered sites known in western Wales (*J. Conch., Lond.* **34**: 186). *Cochlodina laminata* from an old deciduous wood on the Cornish side of the Tamar valley is an interesting outpost of a mainly lowland snail. The finding of *Trichia plebeia* at two places near Carlisle shows that this essentially Midland helicid extends much further north than was previously thought; the specimens were confirmed by dissection by Mr. F. Naggs. *Ceciloides acicula* from Edinburgh is the first Census record from Scotland, confirming mid-19th century reports of this species elsewhere along the south side of the Firth of Forth.

Among 20th century introductions, *Helicodiscus singleyanus* can now be reported from Gloucestershire, *Hygromia limbata* from North Devon, and *Hygromia cinctella* from North Devon and from Somerset. All these no doubt represent recent extensions of range.

Thanks to the work of Dr. A. T. Sumner and Miss S. M. Davies, there have been a large number of slug authentications from Scotland in the past year, giving a clearer picture of the distribution in that country of such species as *Arion flagellus* and *A. owenii*. *Boettgerilla pallens* is obviously spreading rapidly (seven new vice-comital finds), exactly as in England and Wales.

Among aquatic species, the outstanding find has been *Assiminea grayana* in the Shannon estuary, new to Ireland. The two sites are brackish marshes, in tidal tributaries on opposite sides of the estuary and about fifteen miles apart. Its abundance makes it suprising that it should previously have been overlooked in Ireland, especially as both places had been visited by R. A. Phillips in 1906–10 when he discovered the rare *Pseudamnicola confusa* (which Dr. Colville found to be still there). This raises the possibility that *Assiminea* is a recent immigrant (*J. Conch., Lond.* **34**: 256).

Another important freshwater find is of *Pisidium tenuilineatum* living in the R. Wharfe in Yorkshire, by far the most northerly site known for this rare (and apparently declining) species.

M. P. Kerney

COMMUNICATIONS

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Applications published in the Bulletin of Zoological Nomenclature

The following Applications were published on 26 March 1992 in Vol. 49, Part 1 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these Applications is invited for publication in the *Bulletin*, and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

Case 2247
***Balea* Gray, 1824 (Mollusca, Gastropoda): proposed conservation**

Anders Warén
Naturhistoriska Riksmuseet, Sektionen för Evertebratzologi, Box 50007, S-10405 Stockholm, Sweden

Abstract. The purpose of this application is to conserve the name *Balea* Gray, 1824, currently in use for a genus of pulmonate gastropods of Europe, the Azores and the Canary Islands (family CLAUSILIIDAE Mörch, 1864, subfamily BALEINAE). The name has been placed on the Official List of Generic Names in Zoology (Opinion 335) but is threatened by the senior objective synonym *Strombiformis* Da Costa, 1778, for which suppression is proposed. During the last 70 years the name *Strombiformis* has been occasionally and invalidly used for a prosobranch genus, correctly named *Eulima* Risso, 1826 (family EULIMIDAE Philippi, 1853, which includes more than 4,000 species, world-wide, all parasitic on echinoderms).

Case 2634
***Xeromunda* Monterosato, 1892 (Mollusca, Gastropoda): proposed designation of *Helix candiota* Mousson, 1854 as the type species**

F. Giusti & G. Manganelli
Dipartimento di Biologia Evolutiva, Università di Siena, Via Mattioli 4, I-53100 Siena, Italy

Abstract. The purpose of this application is to designate *Helix candiota* Mousson, 1854, an originally included nominal species, as the type species of the terrestrial snail genus *Xeromunda* (HYGROMIIDAE). The name of the present type species, *Helix turbinata* Cristofori & Jan, 1832, is indeterminate but referred to Sicilian material, whereas *Xeromunda* was based on Greek specimens.

The following Applications were published on 25 June 1992 in Vol. 49, Part 2 of the *Bulletin of Zoological Nomenclature*

Case 2801
***Potamolithus* Pilsbry, 1896 (Mollusca, Gastropoda): proposed confirmation of *P. rushii* Pilsbry, 1896 as the type species**

Maria F. Lopez Armengol & Miguel O. Manceñido
Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Paseo del Bosque s/n., (1900) La Plata, Argentina

Abstract. The purpose of this application is to conserve the nominal genus *Potamolithus* from Pilsbry (1896, December), with *P. rushii* Pilsbry, 1896 as the type species, in accordance with universal acceptance. The generic name is available from a paper by Pilsbry & Rush (1896, November) which appeared a month earlier, but *P. rushii* was there only a nomen nudum and so not eligible to be the type species. Species of *Potamolithus* (family HYDROBIIDAE, subfamily LITHOGLYPHINAE) typically inhabit freshwater streams in the Neotropical region and are of considerable biogeographical and palaeontological interest.

Case 2526
***Strombiformis albus* Da Costa, 1778 (currently *Melanella* (Balcis) *alba*; Mollusca, Gastropoda): proposed conservation of the specific name**

Anders Warén
Naturhistorisk Riksmuseet, Sektionen för Evertebratzologi, Box 50007, S-10405 Stockholm, Sweden

Abstract. The purpose of this application is to conserve the specific name of the prosobranch mollusc *Strombiformis albus* Da Costa, 1778 which is threatened by the unused senior subjective synonym *Turbo laevis* Pennant, 1777. The name *albus*, a senior subjective synonym of *Balcis montagui* Leach in Gray, 1847, the nominal type species of *Balcis* Leach in Gray, 1847, is universally in use. The name *Balcis* relates to a group of species which is considered to be subgenerically distinct from *Melanella* Bowdich, 1822 (in the world-wide family EULIMIDAE Philippi, 1853, which includes more than 4000 species, all parasitic on echinoderms).

Opinions published in the Bulletin of Zoological Nomenclature

The following Opinions were published on 25 June 1992 in Vol. 49, Part 2 of the *Bulletin of Zoological Nomenclature*.

Opinion 1677. *Haustator* Montfort, 1810 (Mollusca, Gastropoda): conserved.

Opinion 1678. *Helicarion* Férussac, 1821 (Mollusca, Gastropoda): conserved, and *Helicarion cuvieri* Férussac, 1821 designated as the type species.

Opinion 1679. *Kobeltia* Seibert, 1873 (Mollusca, Gastropoda): *Arion hortensis* Férussac, 1819 confirmed as the type species.

ASSIMINEA GRAYANA FLEMING NEW TO THE IRISH FAUNA

In May 1991, I visited two sites in the Shannon estuary in an attempt to rediscover *Pseudamnicola confusa* (Frauenfeld), a brackish-water prosobranch, that had not been collected there since the turn of the century.

The first site, Ferry Bridge over the River Maigue on the south side of the Shannon estuary, 19 km west of Limerick (Irish Grid Reference R (11) 483521) was visited on May 26th. By the east bank of the river, south of the bridge, there is a large patch of greater pond sedge (*Carex riparia*). Not only was *P. confusa* found living here but also *Assiminea grayana*, a species hitherto unknown from Ireland. *A. grayana* was abundant on mud under the *Carex* and amongst the surrounding vegetation, mainly tall grass. The specimens were all small, up to half-grown (3 mm), and no sign of even dead adults could be found although larger specimens were found on the steeper mud banks of the river. On a second visit on 28th May 1992, the density of *A. grayana* under the *Carex* was estimated at 300 m⁻². At this locality there is a strong current with considerable tidal range, the mud being completely covered at spring tides. In addition to *A. grayana*, the following species were also found at this site: *Pseudamnicola confusa*, *Potamopyrgus jenkinsi*, *Ovatella myosotis*, *Lymnaea truncatula*, *L. palustris*, *Anisus leucostoma*, *Succinea putris*, *Oxyloma pfeifferi*, *Punctum pygmaeum*, *Discus rotundatus*, *Deroceras reticulatum*, *Euconulus fulvus*, *Ashfordia granulata* and *Trichia hispida*.

On the same occasions I visited the second site at Clarecastle, 2 km south of Ennis, on the north-east side of the bridge over the River Fergus, Co. Clare (Irish Grid Reference R (11) 356740). Here I only found *A. grayana* in very small numbers and none on the second visit. The upper bank was steeper here and was better drained. The associated species were similar to those at Ferry Bridge with the addition of *Helix aspersa*.

R. A. Phillips (*Irish Naturalist* **18** (1909), p. 143) first found *Pseudamnicola confusa* near New Ross, Co. Wexford in 1907, on 8th May 1909 he found it at Ferry Bridge and in May 1910 at Clarecastle in extreme abundance all over the tidal marshes and brackish drains associated with *Potamopyrgus jenkinsi*, *Lymnaea palustris*, *L. truncatula*, *Anisus leucostoma* and *Oxyloma pfeifferi*. It seems very unlikely that he, and the other eminent Irish conchologists of the day, would have overlooked the more significantly sized *A. grayana* if it were present or have disregarded it as a marine species since records of *Hydrobia ulvae*, *Ovatella myosotis* and *Leucophytia bidentata* were regularly sent to the National Recorder. It therefore seems that *A. grayana* may be a recent arrival in Ireland.

Hitherto *A. grayana* was only known from coasts bordering the North Sea. In Britain it occurs sporadically between Kent and the Humber and the continent from the Netherlands north to Denmark. It is limited to the upper parts of salt marshes at levels wetted only by spring tides. It is not happy submerged and tends to crawl out of water, resisting desiccation for up to six months (Fretter, V. & Graham, A. *J. moll. Stud. Suppl.* **5** (1978), p. 147).

There are extensive areas of marsh in the Shannon estuary which in appearance are not unlike the tidal marshes of the River Waveney and neighbouring rivers of the Broads of East Anglia. The ecosystem also seems similar and *A. grayana* may well prove to be quite widespread in this area.

Although these *A. grayana* are the first authenticated records from Ireland, there is one tantalizing literature reference. J. G. Jeffreys (*British Conchology* **5** (1869), p. 100) noticed a single shell of *A. grayana* in T. W. Warren's collection in Dublin, which Warren assured him had been found in the salt marshes at Portmarnock, north of Dublin. Although Jeffreys understandably doubted its authenticity, its occurrence in the Shannon estuary makes this record slightly more plausible.

I thank Dr. M. P. Kerney for the information he kindly contributed to this communication.

B. COLVILLE,
Pool Foot, Clappersgate, Ambleside, Cumbria LA22 9NE

ACLIS GULSONAE AND OTHER NEW MARINE RECORDS FROM
DUNSTAFFNAGE CHANNEL AND LOCH ETIVE

In April 1992 we were able to carry out some dredging work in Dunstaffnage Channel and Loch Etive, Scotland as part of a PORCUPINE Society meeting to Oban. Dunstaffnage Channel is relatively shallow with a depth of up to 25 m and with a substrate of sand, gravel and shell, and kelp attached to pebbles. Loch Etive has a diversity of substrates and a maximum depth of 100 m. A detailed benthic survey of this area was last carried out by the Dunstaffnage Marine Laboratory 20 years ago (Gage J., *J. mar. biol. Ass. U.K.* **52** (1972) pp. 237–276). In addition to providing much data for the Marine Census, our work has yielded new and important distributional information.

Hyala vitrea (Montagu, 1803). This is an apparently rare species in W. Scotland only having been recorded alive since 1950 from muddy gravel in Loch Creran (Gage J., 1972 *op. cit.*) and Loch Bracadale, Isle of Skye in 1991 (JNCC, unpublished data). There are several old records, mostly of dead shells, mainly from the Firth of Clyde and the Outer Hebrides. Two adults with heavily corroded shells were found alive in soft black mud, N of Airds Bay, Loch Etive ((56°27.5'N, 05°15.2'W) at a depth of 52 m. The associated molluscs comprised *Nucula nucleus*, *N. sulcata*, *Nuculoma tenuis*, *Mysella bidentata* and *Corbula gibba*.

Aclis gulsonae (Clark, 1850). Four live animals and one fresh shell were collected from a haul of shell gravel and weeds dredged from 18–25 m in Dunstaffnage Channel (56°27.3'N, 05°26.1'W). Three dredge samples from this station contained an exceptionally rich assemblage of molluscs with 53 species found living. *A. gulsonae* is a southern species that extends from Madeira to the British Isles. Since 1950 it has only been recorded living once from north-west European waters from the area around Roscoff, France (Rodriguez Babio., *Trav. Stat. Biol. Roscoff (NS)*. **20** (1973) pp. 1–4. Old records from W. Scotland are also infrequent. It was recorded from Skye by Jeffreys (*Ann. Mag. nat. Hist.* **6** (1866) pp. 387–397) and from several localities by Marshall (e.g. *J. Conch., Lond.* **9** (1899) pp. 165–171), however, most of the pre-1900 records are from shell sand off Lamlash Bay, Arran. There is a recent empty shell record from Clachan Sound, south of Oban (Smith S. M. & Nunn J. D., *Conchologists' Newsletter* **95** (1985) pp. 316–318. The only other live records (all pre-1950) from British waters are from Sea Areas S16, S18, S26 and S29a).

Haedropleura septangularis (Montagu, 1803). One live specimen was found in shell gravel and mud dredged from 32 m at Kilmaronag, Loch Etive (56°27.5'N, 05°20.1'W). The associated molluscs comprised mainly bivalves, particularly *Nucula nucleus*, *Tridonta montagui*, *Parvicardium ovale* and *Timoclea ovata*. There are only two previous live post-1950 records for the west of Scotland: one specimen in mud, shells and stones dredged from 12 metres, Heather Island Sound, Firth of Lorn (56°24.6'N, 05°30.1'W) in 1979 (S. M. Smith Colln.), and sublittorally from sandy bays off the Isle of Cumbrae, Firth of Clyde (Clark R. B. & Milne A., *J. mar. biol. Ass. U.K.* **34** (1955) pp. 161–180).

Chrysallida indistincta (Montagu, 1803). Although there are a number of recent dead shell records, live records from W. Scotland are very sparse. It has been found in littoral algae on three occasions: on Skye, Lewis and in Loch Torridon and sublittorally from sand off Tiree (all S. M. Smith). There are also several old records, most of which are from the Clyde (Allen J. A., *The fauna of the Clyde Sea area Mollusca* (1962) Millport). We can report two specimens of *C. indistincta* living in shell gravel in Dunstaffnage Channel (site as for *Aclis gulsonae*).

Ondina diaphana (Jeffreys, 1848). Three live specimens were found in Dunstaffnage Channel (site as for *Aclis gulsonae*). The only other recent record is from littoral algae in Loch Roag, Lewis (Smith S. M., *Proc. Roy. Soc. Edinb.* **77B** (1979) pp. 173–187). It was also reported from Rathlin Island, Antrim in 1981 by Brisco (*The present living marine molluscan fauna of the northeast of Ireland*. Report to the R. L. Praeger fund for Field Natural History). At present we are exercising caution in recording these specimens as *O. diaphana* rather than *O. perezi* (Dautzenberg & Fischer, 1925). The latter is considered to be an ectoparasite of the sipunculan worm *Phascolion strombi* (Montagu, 1804) which inhabits old mollusc shells, particularly *Turritella communis* Risso, 1826. These were not found in our dredge samples as the habitat in Dunstaffnage Channel is unsuitable, although both *Turritella* and *Phascolion* are common close by (J. Gage, *pers. comm.*). On this basis we have followed Seaward (*Distribution of the marine molluscs of north west Europe* (1990), NCC, Peterborough) in referring our specimens which were not associated with *Phascolion* to *Ondina diaphana*. The precise habitat and host for *O. diaphana* is unclear, although the record from Lewis suggests that it might be associated with serpulid or other worms living on algae. This also approximates to the habitat likely to be available in Dunstaffnage Channel, rather than that required by *O. perezi*. There are a few old records of the aggregate from the W. Scotland area: found at several localities by Marshall (*J. Conch., Lond.* **9** (1900) pp. 284–296) and Skye (Jeffreys, *op. cit.*).

We are grateful to Professor J. B. L. Matthews, Director of the Dunstaffnage Marine Laboratory for making the research vessel *Seol Mara* available to us for this dredging work, and to Mr. Robin Harvey for arranging the trip and his helpful information.

I. J. KILLEEN¹ & S. M. SMITH²

¹ 163 High Road West, Felixstowe, Suffolk IP11 9BD

² Woodleigh, Townhead, Hayton, Carlisle, Cumbria CA4 9JH

FURTHER RECORDS OF *NOEMIAMEA DOLIOLIFORMIS* (JEFFREYS)

Last year we reported the first post-1950 live British record of *Noemiamea dolioliformis* from a rocky shore at Criccieth, N. Wales (Light, J. M. & Killeen, I. J., *J. Conch., Lond.* **34** (1992) pp 117–118). It has since been recorded from two further sites: one on the west coast of Ireland and the other on the east coast of Kent.

The first site lies in Tralee Bay on the Dingle peninsula, Co. Kerry, Ireland (52°17.2'N, 10°11.7'W). A single live specimen of *N. dolioliformis* was retrieved from a sample of mixed red and brown algae, collected from large isolated boulders in a sheltered, sandy bay. The associated molluscan fauna was very rich and included two other pyramidellids, *Odostomia turrita* and *Brachystomia scalaris*.

The species was then found again at Joss Bay, N of Broadstairs, Kent (51°22.9'N, 01°27.1'E). The habitat consists of an extensive wave-cut Chalk platform to the north of a small sandy bay. A small sample of mixed algae yielded 5 living specimens of *N. dolioliformis* along with *Partulida spiralis* and *Brachystomia scalaris*. The other molluscs in the algae sample comprised the low diversity of species generally associated with this part of the Channel (e.g. *Rissoa parva*, *R. interrupta*, *Lacuna pallidula*).

At both sites the rocks were extensively colonized by the tube dwelling polychaete *Pomatoceras triqueter* (L.). This is a known host of several pyramidellid species (Fretter, V., Graham, A. & Andrews, E., *J. moll. Stud., Suppl.* **16** (1986) pp. 557–649). The host of *N. dolioliformis* is apparently unknown, but would appear to be also associated with *Pomatoceras*. These three recent records indicate that *N. dolioliformis* is geographically widespread in the southern British Isles, however the lack of records from other localities on the south coast suggest that it is genuinely rare.

I. J. KILLEEN

163 High Road West, Felixstowe, Suffolk IP11 9BD

NEW RECORDS OF BIVALVES FROM PAKISTAN
(LAYARI RIVER).

The bivalves of the North-eastern Arabian Sea are infrequently studied and poorly known. Melville J. C. & Standen R., (*Proc. Zool. Soc. Lond.* Vol. II, (1906) pp 783–848) list species from the Mekran Coast, Karachi and Bombay. Khan, M. D. & Dastagir, S. G. (*Res. Coun. Pakistan* (1972) pp 1–206) give a review of bivalves from Pakistan, but ecological data on the fauna of this region is sparse.

Following a recent pollution incident many bivalves were found in the estuarine region of the Layari River, a small ephemeral stream of 50 km length which bisects Karachi, before draining into the Arabian Sea. A list of these is presented below. Those marked with an asterisk are recorded from Pakistan for the first time. Voucher specimens are deposited in the freshwater Zoological Record (F.Z.R. 1982, F.B.) of the Limnology and Freshwater Fishery Section, Department of Zoology, University of Karachi, Pakistan.

* <i>Pillucina fischeriana</i> (Issel)	Muddy sand	estuarine
<i>Diplodonta</i> sp.	Mud	estuarine
<i>Bucardium coronatum</i> (Schroeter)	Muddy sand	estuarine
* <i>Mactra complonata</i> Deshayes	Sand flats	estuarine
* <i>Tellina capsoides</i> Lamarck	Sand	estuarine
* <i>Tellina iridescens</i> (Benson)	Sand	estuarine
* <i>Corbicula striatella</i> Deshayes	Sand-mud	freshwater
<i>Villorita</i> sp.	Sand flats	estuarine
<i>Bassina caluphylla</i> (Philippi)	Rocky crevices	deltaic region
* <i>Timoclea imbricata</i> (Sowerby)	Mud	estuarine
* <i>Timoclea crakana</i> (G. & H. Nevill)	Sand flats	estuarine
* <i>Meretrix casta</i> (Gmelin)	Mud flats	estuarine
* <i>Peleyora cylanica</i> (Dunker)	Sand	estuarine
* <i>Peleyora excisa</i> (Schroeter)	Sand	estuarine
* <i>Marcia hiantina</i> (Lamarck)	Mud	estuarine
<i>Marcia recens</i> (Chemnitz)	Mud	estuarine

FARIDA BEGUM and SAIYIDA NAZNEEN

Department of Zoology, University of Karachi, Karachi-32, Pakistan.

NEW DISTRIBUTIONAL DATA FOR SOME LAND SNAILS FROM FRANCE AND THE IBERIAN PENINSULA

This communication provides new distributional data from SW. Europe obtained as the result of several periods of field-work (Seddon; July 1983, June & September 1984, June & September 1986; Tattersfield, April–May 1991). Although there has been much recent research on the land snails of the Iberian peninsula the majority of the work published to date has been on the northern provinces. These new distributional records are mainly from the more poorly known regions of southern Spain and Portugal. The data given for each species includes locality, UTM 10 km square grid references, habitat data and collector. The Holyoak-Seddon collection is kept in the National Museum of Wales (NMW).

Vertigo substriata (Jeffreys, 1833) has a distribution covering much of N. Europe becoming more local in the southern part of its range (Kerney, M. P. & Cameron, R. A. D. (1979) *A Field Guide to the Land Snails of Britain and north-west Europe*. Collins, London). In France there are recent records from Pyrénées Orientales (Raven, J. G. M. *Basteria*, **48**: (1984) pp 17–21). Colville, B. (*J. Conch.*, *Lond.* **32**: (1985) pp 145–6) greatly extended the known range giving records from Vosges, Bas-Rhin, Haute Loire and Hautes Pyrénées. Additional records from Locminé, Dept. Morbihan (WU10) and Plemet, Dept. Côtes-du-Nord (WU34) increase our knowledge of its distribution in France (Holyoak-Seddon Colln.).

In southern Europe the species appears to have a mainly montane distribution pattern with records from the Pyrenees (see above), the Italian Alps (Alto Adige; Dolomites) and Cantabrian Mountains (Prov. León, Prov. Oviedo: Raven, 1984, *op. cit.*). Zilch & Jaeckel (*Mollusca. Die Tierwelt Mitteleuropas* (1962), Quelle & Meyer, Leipzig) give a record from S. Portugal, which was much further south than any previous record. Recently live material of this species was collected from the range of Sierra Nevada, at 2 km ENE of Capeleira, Prov. Grenada, southern Spain (VF79; Tattersfield Colln.). The habitat at this montane site was a seepage with rushes (*Juncus* cf. *effusus*), sedges (*Carex* sp.) and herbs (*Hypericum* sp.).

Leiostryla anglica (Wood, 1828) is known from coastal regions of Portugal (Districto Lisboa, Oporto, Faro: Nobre, A. *Mem. Est. Mus. Zool. Univ. Coimbra*, **124**: (1940) pp 1–279), France (Île de Ré), the Channel Islands and has a more extensive range in the British Isles (Kerney & Cameron, *op. cit.*). This species was collected at two sites in southern Spain. These apparently represent the second records for Spain and are much further south-east and further inland than previous records. The localities were El Bosque, 8.5 km W. of Grazelema, Prov. Cádiz, (TF 86; Tattersfield Colln.) and Rio Poquiera, below Pampaneira, Prov. Grenada (VF 79; Tattersfield Colln.). The specimens were collected from sites at intermediate elevations (430 m, El Bosque; c. 800 m, Rio Poquiera) in montane regions amongst ground vegetation of Maidenhair Fern (*Adiantum capillis-veneraris*) on damp flushes within woodland.

Chondrina gasulli (Gittenberger, 1973) was first described from the Vall de Ebo region in Prov. Alicante, Spain (Gittenberger, E. *Zool. Verh., Leiden*, **127**: (1973) pp 246–9). Specimens were collected from a limestone crag 3 km E. of Alcoy, Prov. Alicante (YH 18; Holyoak-Seddon Colln.) extending the known range westwards.

Mastus pupa (Bruguière, 1792). Burgos (*Iberus*, **10**: (1990) pp 281–286) reported this species from Prov. Seville in southern Spain and believed it to be the first record for the Iberian peninsula. However there is an earlier, poorly localized report given by Sacchi (*Proc. First Malac. Congress*: (1965) pp 243–7) of a living population of *Mastus pupa hispaniensis* (West.) isolated in south eastern Andalusia. An additional record from Vejer de la Frontera, Prov. Cádiz (TF 31; Holyoak-Seddon Colln.) extends the known range suggesting that it may be more widespread but local in this region. Further southeast, recent excavations of Ibex Cave, Gibraltar (TF 80; NMW Colln.) yielded fossils of this species. From the stratigraphical context these fossils are likely to be Weichselian (Late Pleistocene) in age, confirming that this species has a long history on the peninsula. Sacchi (1965) speculated that *Mastus pupa* had arrived in the Iberian peninsula from the Rif Mountains as an introduction, possibly the result of human trade of agricultural products. The fossil records from Gibraltar indicates an introduction somewhat earlier in the Pleistocene.

Playgyrona placida (Shuttleworth, 1852). This species, originally known as *P. debeauxiana* (Bgt.), was recorded from Lisbon in W. Portugal by Gittenberger (*Zool. Meded., Leiden*, **50**: (1977) pp 295–301). Waldén (*Ann. Zoo. Fennica*, (1983) **20**: 255–272) pointed out that *P. debeauxiana* (Bgt.) was a synonym of *P. placida* (Shuttleworth, 1852). A further site has been found in S. Portugal at Benisfrim (Districto Faro, Algaive Region, NB 21; Holyoak-Seddon Colln.). The specimens were sieved from leaf-litter on rocky slopes of limestone partially shaded by bushes and herbs. Gittenberger (*Publ. Oças. Soc. Port. Malac.* **13**: (1989) pp 13–16) gave additional information about the distribution of this species and commented on the unusual, and at present rather disjunct, distribution pattern, with records from Madeira, Canaries, Algeria, Portugal and some of the Greek islands.

Toltecia pusillum (Lowe, 1831) (= *Punctum pusillum*). Specimens of *T. pusillum* were collected from a mortared limestone wall NNW. of Cerons (Dept. Gironde, France, XP74; Holyoak-Seddon Colln.). This extends the range in France northwards from the Pyrenees. The shells came from leaf-litter under ivy on the wall which was partly shaded by *Robinia* trees. The range of the species in Spain and Portugal was summarized by Altonaga (*Kobie Serie Ciencias Naturales Bilbao*, no **18**: (1989) pp 123–136). We report additional records from rocky limestone slopes near Portinho da Arrabida (Dist. Setubal, Portugal, NC 50; Holyoak-Seddon Colln.) and moist stream banks near Sanctis-Spiritus (Prov. Salamanca, Spain, QF 10; Holyoak-Seddon Colln.). The records were obtained by sieving leaf-litter at both sites which were partially shaded by trees and bushes.

Oxychilus hydatinus (Rossmässler, 1838). Dead shells of this species were recorded from rocky limestone areas partially shaded by bushes and herbs near Las Cabrezas de San Juan, Prov. Seville (TF 49; Holyoak-Seddon Colln.) and Cabra, Prov. Córdoba, S. Spain (UG 74; Holyoak-Seddon Colln.). These records extended to the known range in the Iberian peninsula (Altonaga, K., *Cuadernos de Invest. Biol.*, **16**: (1990) pp 35–52).

M. B. SEDDON¹ & P. TATTERSFIELD

¹Department of Zoology, National Museum of Wales, Cathays Park, Cardiff, CF1 3NP

REVIEWS

Checklist of British Marine Mollusca by Shelagh M. Smith and David Heppell. National Museums of Scotland Information Series No. 11, published in 1991. ISSN 0952–7737. 114 pp., Price £9.95, post and packing £1.00, from Royal Museum of Scotland, Chambers St., Edinburgh, EH1 1JF.

At last we have an up-to-date taxonomy for the British marine mollusc fauna – and for most of north west Europe too.

A three page introduction discusses the need for a new list, the classification, taxonomy and sources used, and explains the useful system of suffixes denoting brackish, littoral or deepwater species, and those of a southern or northern distribution. There follows a five page systematic list of higher taxa, and then the checklist itself, occupying the bulk – 70 pages – of the work. Copious annotations, indicated by marginal numbers in the checklist, cover the next nine pages, and it ends with five pages of references and a very full 20 page index down to species and variety level, which includes all synonyms. Layout is clear, with good use of different headings, type and indents.

The title *British* is modest and confusing; the area covered includes Ireland and the French Channel coast, and extends into deep Atlantic water well north of the Faroes, 200 miles west of Ireland and 450 miles south west of Land's End, yet stops short only 40 miles east of East Anglia (02°40'). The authors then extend the area – and the list of species – by use of a prefix to:

‘. . . indicate a species which has not as yet been recorded from the present area but which has been found within 1° of latitude or longitude of our limits, and thus might reasonably be expected to occur there’.

This increases the taxonomic value, but should be treated with caution biogeographically; sources for records of the occurrence of prefixed species are not given, and I suspect that the Smith & Heppell ‘1°’ is like the countryman's mile – as far as is required! For instance, Norwegian coastal species are included, and one would have to go 7° east to find the nearest *Parvicardium hauniense*. Choice of an area including the whole North Sea, with a ‘North west Europe’ title would have been more satisfactory and less confusing.

Others are better qualified than I to comment upon the taxonomy and nomenclature, but there are some errors. Most of these are in citation of authorship of taxa, particularly of date of publication, e.g., *Elysia* Risso, 1818, *not* 1826 as shown; *Chrysallida indistincta* (Montagu, 1808), *not* 1803; *Hiatella arctica* (L., 1767), *not* 1758, *Hemiaclis ventrosa* is attributed to G. O. Sars, whereas it should be to Jeffreys in Friele, etc. They are unfortunate in a work which claims that ‘. . . compared with many authors we have investigated more widely . . . particularly in . . . the citing of the correct authorship and date . . .’.

For the Caecidae, the authors follow Aartsen's 1977 review, so including *Caecum armoricum* only as a synonym of *C. glabrum* – wrongly, since they have overlooked Aartsen's 1984 revisions with Hoenselaar (*Basteria*, **48**: 23–26) and with Menkhorst and Gittenberger (*Basteria*, suppl., **2**:27), in which *armoricum* was (and still is; pers. comm. J. J. van Aartsen) considered a good species. This is notwithstanding an acknowledgement to (among others) Aartsen with whom the authors ‘have engaged in lengthy correspondence and discussion’. The authors tell me that they are preparing an ‘Addenda and Corrigenda’ to send out to all who have received a copy.

I would not have expected *Theodoxus fluviatilis* in a British marine list, even as a brackish water species, although it does live in the Baltic in reduced salinity. *Rissoa labiosa* is also

shown as a brackish water species although I suspect that usually it is found in full salinity; conversely, *Assiminea grayana* is listed as littoral – surely a mistake for this obligate brackish water animal. It is surprising to see *Aplysia parvula* in the list without comment; the occurrence of this species in British waters is still subject to confirmation (A. Bebbington, pers. comm.).

It should be noted that there are considerable differences in classification and nomenclature from the earlier list by Smith (in C. M. Howson (ed.), 1987, *Directory of the British marine flora and fauna*, Marine Conservation Society), which must now be regarded as superseded, although this is not specifically stated. Some mention of the *Annotated checklist of Mediterranean marine mollusks* by Sabelli, Gianuzzi-savelli & Bedulli, published in 1990 by Libreria Naturalistica Bolognese, with comments on points of difference of taxonomic treatment, would have been valuable since many species occur in both lists.

In spite of some minor faults, Smith and Heppell are to be congratulated for giving us a valuable, workmanlike and usable document which should receive widespread adoption.

D. R. SEAWARD

British Red Data Books: 3 Invertebrates Other Than Insects edited by J. H. Bratton. Joint Nature Conservation Committee 1991 ISBN 1 873701 00 4 £8.00 (available from: Natural History Book Service Ltd., 2 Wills Road, Totnes, Devon, TQ9 5XN)

This compact 253 page book, which is produced in A5 format, continues from two earlier Red Data Books. The first of these, now in the second edition, dealt with vascular plants and this was followed in 1987 by a volume dealing with British insects.

The book starts with a foreword by Sir William Wilkinson, former chairman of The Nature Conservancy Council. Then, following a brief introduction, there are sections on the selection of species for the book, British and international legislative protection for non-insect invertebrates and explanations of the threat definitions and criteria for included taxa. The bulk of the book comprises data sheets, each dealing with an individual species. Throughout the text are 18 black and white photographs illustrating a variety of habitats.

Species included in the Red Data Book are those that are considered to be under threat, either as a result of evidence from biological recording for well documented groups like Mollusca, or in habitat terms for invertebrate groups where recording schemes are, as yet incomplete. The book covers a total of 144 species from 8 phyla including 33 species of brackish, freshwater and terrestrial Mollusca. The status of each species is linked to one of six categories of threat. These include (1) *extinct in Britain* (applying to no molluscan taxa); (2) *endangered-R.D.B.1* (including *Vertigo angustior* and *Segmentina nitida*); (3) *vulnerable-R.D.B.2* (e.g. *Gyraulus acronicus* and *Lymnaea glabra*); (4) *rare-R.D.B.3* (e.g. *Vertigo moulinsiana* and *Helicodonta obvoluta*); (5) *insufficiently known R.D.B.K.* (e.g. *Tandonia rustica* and *Caecum armoricum*) and (6) *endemic-R.D.B.5* (no Mollusca fall into this category although *Leiostyla anglica* and *Ashfordia granulata* are “nearly” there!) Species that have been given Red Data Book status but subsequently prove to be out of danger are classified as *R.D.B.5*.

Each species is described on a data sheet which is divided into eight sections covering identification, distribution, habitat, ecology, status, threats, conservation and sheet author. Most of the molluscan sheets are written by Dr. M. P. Kerney with a smaller number of brackish species dealt with by Mr. D. R. Seaward.

This book is of considerable importance in drawing attention to a section of our fauna that has, perhaps for too long, not been given the recognition, appreciation or environmental consideration that it deserves. It promotes awareness of the very special needs of the taxa considered, as well as illustrating the fragile and vulnerable nature of many of the habitats

upon whose existence, their future as members of our native fauna depends. This clear, tightly written book can be thoroughly recommended to all those with either a specific interest in the groups considered, or a wider concern for the continued well being of the diversity of habitats that these threatened species depend upon.

M. J. WILLING

The Land and Freshwater Molluscs of Suffolk: an Atlas and History, by I. J. Killeen. 171 pp, 35 colour plates. ISBN 0-9508154-4-6, 1992. Published by The Suffolk Naturalists' Society, c/o The Museum, High Street, Ipswich, Suffolk, IP1 3QH. Price, including postage, UK – £10, overseas – £13.

Those of you who have been involved in faunal census surveys will know the effort required to maintain enthusiasm to complete such schemes. It is, therefore, particularly pleasing to see Ian Killeen's study of the land and freshwater molluscs of Suffolk appear in print. Moreover, this book, which represents over ten years work on the molluscan fauna of Suffolk, principally by the author, has been produced to the high standard which it deserves.

The *Atlas and History* presents the distribution of all the land and freshwater molluscs (including *Pisidium* spp.) known to be living in Suffolk. The area studied is that of the Watsonian vice-counties of East and West Suffolk (VC's 25 and 26) and the mapping unit is the "Tetrad" (2 km × 2 km square). The two vice-counties comprise 1089 tetrads of which 74% have been examined with excess of 25,000 records.

Although the distribution maps form the basis of the book, there is a great deal more to it than that. The subtitle "An Atlas and History" is entirely appropriate. The history of recording Mollusca in Suffolk is well presented in the early chapters. The earliest record of a mollusc living in Suffolk dates from 1784 but the fossil record is also considered. Quaternary sediments which contain *Vertigo geyeri* and *V. genesii* and a Flandrian tufa which contains *Discus ruders* and *Nesovitrea petronella* attest to the climatic changes which have occurred in "Suffolk" in the distant past. Throughout the book, records are placed in an historical context. For each species the earliest record is presented and distribution is discussed in terms of geology, climate and habitat. These factors are themselves the subject of discussion in the opening chapters. In the case of the freshwater molluscs, the base map includes the major rivers.

Apart from the extinctions which have occurred in the geological past, Killeen's extensive research has shown that several other species no longer occur in Suffolk. For example, *Zonitoides excavatus* appears to have been extinguished by 1865 and *Helicogona lapicida*, once widely distributed in the County though always rare, was last seen in 1972. However, not all the changes observed are extinctions. In 1878 *Potamopyrgus jenkinsi* was first discovered in Suffolk and the process of introduction has continued with the most recent newcomer being *Limax valentianus* – in 1986. An outstanding example of the value of intensive studies of distribution is shown by the discovery of several sites for two rare species of vertiginid snails, *Vertigo angustior* and *V. pusilla*. In Suffolk these live together in well defined coastal wetland habitats. *V. pusilla* has also been found in another unexpected habitat, the broad-leaved woodland fringe of conifer plantations in the Breckland. Similarly, the discovery of *Limax cinereoniger* in Suffolk, the first record for East Anglia, is of considerable significance to the distribution of Mollusca in Britain. Other interesting patterns of distribution have become evident through the study. Compare the complementary distributions of *Oxychilus helveticus* and *O. alliarius*; *Cepaea nemoralis* and *C. hortensis*; the stability of distribution of *Arianta arbustorum* with the changing pattern of distribution of *Pupilla muscorum*.

Undoubtedly, an outstanding feature of this book is the inclusion of Derek Rands' superb colour photographs of living molluscs. Several of the smaller species are presented in exquisite detail, although I would have liked to have seen some indication of size on these plates since this is not readily grasped in many of the photographs.

The text concludes with a list of useful addresses, references and a species index.

This is a very well presented Atlas, free of errors, which, in addition to its intrinsic value, will give encouragement and set the standard for future distributional studies.

B. COLES

Terrestrial Slugs. Biology, Ecology and Control. By A. South. Chapman & Hall, London. ISBN 0 412 368102. 428 pages. £49.00.

South's stated objective: 'to present a review of current knowledge of the biology and ecology of slugs, together with their status and control as pests' is achieved by a thorough and scholarly work of a high standard. A summary of slug groups, with particular reference to the British fauna, is followed by detailed reviews of anatomy, physiology, reproduction, behaviour, life cycles and ecology. Additional topics surveyed include predation, parasites and disease, slugs as pests and their control. Appendices cover methods of culture, the anaesthetising, narcotising and preserving of slugs.

The text is interspersed with a diverse array of facts that I found fascinating. In the review of predation, for example, is the case of the garter snake *Thamnophis elegans* which is polymorphic, having a slug-eating genotype, for which slugs may constitute 90% of the diet, and a slug-refusing morph that would starve to death rather than feed on slugs. In the section on slugs and man the use of slugs to combat ailments ranging from tuberculosis to lumbago and warts are activities of our recent past that I was not aware of, as was the use of *Arion ater* to lubricate cart wheels. However, I did know of a slug horror story that was set in my own South London suburb of Merton, which I believe was made into a film.

Because slugs represent a diverse array of heterobranch groups, much of the information is relevant to terrestrial gastropods in general. In fact, I have always been puzzled that so many workers should concentrate on such an unnatural group as slugs, independently of shelled gastropods. South does not set out to consider detailed aspects of systematics and taxonomy beyond the British fauna. There are few references to monographic and faunistic studies, particularly of tropical groups, and there is little discussion of relationships. For example, while stating that athoracophorids are unlike any other slugs, there is no discussion of their similarities with the anomalous succineid snails which may yet prove to be opisthobranchs. I found the discussions of the evolution of slug form and diversity of slug families disappointing because of their brevity.

Whilst recognizing that the bias is toward European species, South points out that most published information is on European species and that several of these now have a cosmopolitan distribution. Those wishing to use slugs in teaching or research, or who are concerned with slugs as pests, are particularly well-catered for. However, there is no doubt that South has succeeded in providing a source of reference and extensive bibliography that will provide indispensable to any slug worker regardless of their specialization or geographical province.

F. NAGGS

REVIEWS

Smith, B. J. (1992). Non-Marine Mollusca. In: Houston, W.W.K. (ed) *Zoological Catalogue of Australia*. Canberra: AGPS Vol 8, xii 405 pp. ISBN 0 644 14598 6. Aus \$49.95 casebound.

This formatted catalogue by Dr. Brian Smith is a major summation (and the first since Iredale's 1930s lists) of the state of knowledge of Australia's non-marine mollusc fauna. It is essentially a print out of a concise computer data base which gives the current (to 31 December 1990) state of taxonomic and biological knowledge of the Australian fauna – in this case Bivalvia, Gastropoda: Prosobranchia and Gastropoda: Pulmonata including the introductions. Since the catalogue provides a complete Australian synonymy for each valid genus-group and species group it is an essential reference work for any zoologist, but especially taxonomists, concerned not only with the Australian fauna but also with the fauna of the globe as a whole.

For easy location Families are listed in alphabetical order within each Class or sub-Class, but Family relationships are summarized in the Introduction. Generic and species names are also treated alphabetically. It might have been helpful to tabulate generic relationships in the more heavily represented families, such as the Camaenidae, but this is a nit-pick. Each entry at genus and species level gives essential references and other data such as type locality and location of types, brief, standardized, information on distribution (including extra-limital distribution, where applicable, for genera) and, for species, ecological preference.

There are clear statements of which families are in need of revision and lists of species of uncertain status; these features enhance the value of this work. There is a taxonomic index and the appendices include a listing of the taxonomic decisions made in this work.

As far as the indigenous fauna is concerned it is interesting that, despite justified criticisms, the work of the late Tom Iredale laid the groundwork for this catalogue. There were however some slight surprises over the introductions: the inclusion of *Euconulus* in the Helicarionidae (p. 229), the use of Cionellidae for Cochlicopidae (p. 208), and the acceptance of a tentative 1952 record of *Ena montana* from Sydney (p. 221).

The volume is very well produced with eminently readable type, and I was unable to find any typographical errors.

Dr. Brian Smith is to be congratulated on the fine result of his major project. It will remain a standard reference work for many years – thoroughly recommended.

D. C. LONG

Eocene Mollusca from the vicinity of McCulloch's Bridge, Waihao River, South Canterbury, New Zealand: Palaeoecology and systematics. Phillip A. Maxwell. New Zealand Geological Survey Paleontological Bulletin 65, 288 pp, 30 plates. ISSN 0114-2283. 1992. Price NZ/US\$70.

This is another thorough study by Phillip Maxwell of a New Zealand Tertiary fauna. It is based on his Ph.D. dissertation and it is a loss to New Zealand palaeontology that Phillip was made redundant before this work was published. The scope of the monograph is the 250 species of Mollusca from the Middle to Late Eocene Waihao Greensand and Ashley Mudstone exposed in the Waihao River, on South Island. Nine new genus group taxa are proposed for gastropods and 89 new species of Mollusca are very adequately described.

The standards of writing, typography, and photography are as usual very high but, as with other publications in this series, it is not easy to find one's way from plate to text.

Comparisons are made with other New Zealand faunas of roughly comparable age but, a minor point, there is no considered overall comparison with mid-shelf faunas of similar age

outside New Zealand, though extra-territorial distributions are mentioned at various places in the text.

In some families, particularly the Turridae, where a species can be highly variable, there has been extensive and necessary species-level synonymising. A minor comment is that on page 150 it is stated that *Orthosurcula beui* is the only record of *Orthosurcula* outside the Palaeogene of the United States. A European Miocene fossil with the specific name of *steinvorthi* Von Koenen, 1872 was ascribed to *Orthosurcula* by Janssen (1984, *Mollusken uit het Mioceen van Winterswijk-Miste*: 271).

This very professional publication is thoroughly recommended to all interested in Tertiary Mollusca and to students of New Zealand Mollusca in general.

D. C. LONG

INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr R. C. Preece, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ.**

PAPERS Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

Journal of Conchology

Vol. 34, Part 4, December 1992

Contents

	PAGE
PAPERS	
S. GOFAS and F. FERNANDES—The Marginellidae of Angola: The Genus <i>Volvarina</i>	187
N. YONOW—Observations on the Diet of <i>Philinopsis cyanea</i> (Martens) (Cephalaspidea: Aglajidae)	199
B. MUÑOZ and C. PAREJO—Redescription of <i>Suboestophora gasulli</i> nov. comb. for <i>Oestophora</i> (<i>Gasullia</i>) <i>gasulli</i> (Gastropoda: Pulmonata)	205
R. C. PREECE— <i>Cochlicopa nitens</i> (Gallenstein) in the British Late-glacial and Holocene	215
H. DEKKER, R. G. MOOLENBEEK and S. P. DANCE— <i>Turbo jonathani</i> , A New Turbinid Species from the Southern Coast of Oman (Gastropoda: Turbinidae)	225
S. P. DANCE, R. G. MOOLENBEEK and H. DEKKER— <i>Umbonium eloiseae</i> (Gastropoda: Trochidae), A New Trochid Species from Masirah Island, Oman	231
PAULINO J. S. DE SOUZA JR.—A New Species of Marginellid (Gastropoda: Prosobranchia) from the North Coast of Brazil	237
OBITUARIES	
KATHLEEN ROSEMARY SMYTHE	243
GORDON OSBORN FLS	246
COMMUNICATIONS	
INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE	255
B. COLVILLE— <i>Assiminea grayana</i> Fleming New to the Irish Fauna	256
I. J. KILLEEN and S. M. SMITH— <i>Aclis gulsonae</i> and Other New Marine Records from Dunstaffnage Channel and Loch Etive	257
I. J. KILLEEN—Further Records of <i>Noemiamea dolioliformis</i> (Jeffreys) ..	258
F. BEGUM and S. NAZNEEN—New Records of Bivalves from Pakistan (Layari River)	258
M. B. SEDDON and P. TATTERSFIELD—New Distributional Data for some Land Snails from France and the Iberian Peninsula	259
PROCEEDINGS	249
REVIEWS	261

Journal of Conchology

34, Part 5

ISSN 0022-0019

June 1993



**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN
AND IRELAND**

51 Wychwood Avenue, Luton, Bedfordshire LU2 7HT

Hon. Secretary: Mrs S. DAVIES,
5, The Deans, Portishead, Bristol BS20 8BG

Hon. Treasurer: Mr. A. SECCOMBE,
26 Courtland Avenue, Ilford, Essex IG1 3DW

Hon. Editor: Dr. R. C. PREECE,
Department of Zoology, University of Cambridge,
Downing Street, Cambridge CB2 3EJ.

Member's subscription: £21 per annum. **Entrance fee:** £1.

Family membership: £23 per annum.

Institutional membership: £30 per annum.

Students membership: £10

Meetings are held at the British Museum (Natural History) at 2.30 p.m. usually on the third Saturday of each month from October to May. Field Meetings are held in the summer.

Publications: Members receive

The Journal of Conchology (usually two numbers a year).

The Conchologists' Newsletter (quarterly).

For back-numbers of these publications and special numbers please apply to Mr A. Norris, Leeds City Museum, Municipal Buildings, Leeds LS1 3AA.

Programme Secretary: Mr. I. J. KILLEEN, 163 High Road West, Felixstowe, Suffolk IP11 9BD.

Marine Census Recorder: Mrs. J. LIGHT, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN.

Non-marine Census Recorder: Dr. M. P. KERNEY, Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD.

Newsletter Editor: Mr. P. LEE, Rochdale Cottage, Camps Heath, Lowestoft, Suffolk NR32 5DW.

COVER DESIGN: *Muricanthus nigratus* (Phillippi) by D. G. Reid.

NOTICE

Payment by Overseas Members

Overseas members are reminded that all monies due to the Society are payable in sterling.

MARGARITIFERA DURROVENSIS PHILLIPS, 1928: TAXONOMIC STATUS, ECOLOGY AND CONSERVATION

H. C. G. CHESNEY^{1*}, P. G. OLIVER², G. M. DAVIS³

(Accepted for publication, 17th October, 1992)

Abstract: An adequate understanding of the systematics of endemic taxa is necessary for effective conservation policies. The hard water mussel, *Margaritifera durrovensis* Phillips, 1928 is endemic to Ireland but its taxonomic status has been the subject of debate. This study compares populations of *Margaritifera margaritifera* (from Ireland, Scotland, Wales and N. America) with *M. durrovensis* from the River Nore. Aspects of shell morphology, shell structure, anatomy and genetics are used in the analysis and the results indicate that *M. durrovensis* is an ecophenotype of *M. margaritifera*. The geological history of *M. margaritifera* in Ireland is reviewed along with the ecology, population size and status of *M. durrovensis*. Proposals are made for the conservation of the ecophenotype as it is an invaluable tool for the study of ecological adaptation and evolution.

Key words: *Margaritifera*, taxonomy, genetics, ecology, conservation, Ireland.

INTRODUCTION

In many European countries there has, over the last decade, been increasing concern about the drastic population decline and future survival of the freshwater pearl mussel, *Margaritifera margaritifera* (L.). This has resulted in a large increase in research and review papers on *M. margaritifera*. Almost without exception *M. margaritifera* has been described as a soft water species so it was not surprising that shells (discovered in the P. B. Mason collection) taken from the hard waters of the River Nore at Durrow, Co Laois caused some debate. Differences in shell morphology and the unusual habitat led Phillips (1928) to describe the Nore margaritifera as a new species, *Margaritifera durrovensis*. Almost immediately Stelfox (1929) refuted the new species and stated that it was no more than a hard water form of *M. margaritifera*. Haas (1948) reaffirmed Stelfox's conclusion. Throughout Europe the survival of the Unionoidea is threatened and this has led to their placement on the lists of species and subspecies in need of urgent conservation. These conservation proposals have rekindled the debate surrounding *M. durrovensis*. The inconclusive and often contradictory historical data suggest that a complete review is necessary. Features of shell morphology, shell structure, anatomy and genetics are used to assess the taxonomic validity of *M. durrovensis* and available data on its distribution and ecology are summarised.

SYSTEMATICS

Historical

Phillips (1928) gave diagnostic characters of the shell. Anatomical data were given by Bloomer (1928) who also commented that *M. durrovensis* corresponded with Ortmann's

¹ Dept. of Zoology, Ulster Museum, Belfast, BT9 5AB, N. Ireland, U.K.

² Dept. of Zoology, National Museum of Wales, Cardiff, CF1 3NP, Wales, U.K.

³ Dept. of Malacology, Academy of Natural Sciences, Philadelphia, PA 19103, USA.

*formerly Ross

(1912) description of *M. margaritifera*. In a subsequent paper Bloomer (1932) compared the anatomy of *M. margaritifera* from a number of localities in Ireland, Scotland and England. He drew attention to the lack of anatomical differences between *M. margaritifera* and *Margaritifera auricularia* (Spengler, 1973) as noted by Ortmann (1913) and Haas (1924). The year after its publication however another Irish conchologist, Stelfox (1929), dismissed *M. durrovensis* as no more than a form that had become acclimatised to the hard waters of the Nore. The description of *M. durrovensis* and the publication of records from other hard waters in the British Isles (Boycott 1936), forced Haas (1948) to reassess his view that *M. margaritifera* was restricted to soft waters. From his wide experience of continental forms and species, he presented a cogent argument for not giving the hard water form any nomenclatural status. However he noted its similarity to specimens of *M. brunneus* Bonhomme, 1840 from the River Vaur, Aveyron, France.

SHELL MORPHOLOGY

Introduction

Shell morphology has been the traditional source of taxonomic determinations in the Unionoidea and the majority of diagnoses of *M. durrovensis* have relied on such data. From Phillips' (1928) original description it is instructive to note the frequency to which he refers to *M. auricularia* as we believe that this indicates the extent to which the environmental differences, and water chemistry in particular, were influencing the conchological comparisons. Such was the belief that *M. margaritifera* was an exclusively soft water species (Haas 1911) that it led Phillips to compare his hard water form with the only other hard water species, namely *M. auricularia*.

Materials

Given the emphasis placed upon the hard water preference of *M. durrovensis* we have compared this taxon with other populations from both hard and soft waters (Table 1). We have classified the rivers sampled in this study as either having hard ($>50\text{mg CaCO}_3/\text{l.}$), intermediate ($10\text{--}50\text{mg CaCO}_3/\text{l.}$) or soft water ($<10\text{mg CaCO}_3/\text{l.}$) but of course there are no absolute values to distinguish them.

Methods

In this study we have used some morphometric data derived by direct measurements of the valves and subsequent bivariate statistical analysis using Statview SE TM. We have not used

Table 1. Rivers, river chemistry and sample sizes used for shell morphology analysis

Population	Sample size (N)	pH	Ca ²⁺ mg/l	Total hardness mg CaCO ₃ /l
Hard Water				
Nore (Ireland)	40	7.9–8.3	90	245
Intermediate Hard Water				
Blackwater (Ireland)	40	6.6–7.9	—	26–115
Usk (Wales)	6	6.4–8.5	24	48–112
Wye (Wales)	22	6.8–8.9	—	28–187
Soft Water				
Derreen/Slaney (Ireland)	25	7.1–7.5	—	—
Owenea (Ireland)	48	6.5–7.7	4–7	—
Spey (Scotland)	30	6.5–6.7	6–11	—
Kerry (Scotland)	30	6.6–7.4	—	8–19

multivariate analysis as we are interested in those features that characterise *M. durrovensis* rather than those that separate morphological groups. We are already aware that shell morphology is highly variable and that it is possible to recognise distinct forms. From previous descriptions by Phillips (1928) and Bloomer (1928), the following list of characters have been used to distinguish it from typical *M. margaritifera*:

- 1. Smaller maximum length
- 2. Heavier, thicker shell
- 3. Non decorticated umbones
- 4. Presence of a lunule
- 5. Curvature of the hinge plate
- 6. More deeply impressed muscle scars
- 7. Muscle scars rugose
- 8. Muscle scars larger
- 9. Posterior pedal retractor scar separated from posterior adductor scar by a raised shelly ridge
- 10. Juvenile shell with wavy rugae coincident with growth lines and not drawn out on the gonial slope

Results

Maximum shell length: Table 2 lists the maximum length of mussels known to us from the rivers studied. The *M. durrovensis* form, that is the Nore and Suir samples, has a relatively low maximum length but it is in the same order as that for the Usk and is greater then that for the Wye. The small length of the Wye mussels was used as a subspecific character by Bloomer (1927) in his description of *M. m. var. siluriana*. Intraspecifically a relationship is known to exist between animal size and temperature (Bergman's rule) but extrapolation to a relationship of size with latitude requires caution. However Bauer (1991, 1992) contends that in *M. margaritifera* the growth constant increases with increasing temperature. The accelerated growth reduces life-span and therefore reduces maximum length. Bauer also states that increasing eutrophication also reduces maximum length but to a lesser degree than temperature. The rivers Nore, Suir and Wye (Wales) are all towards the south of the range of *Margaritifera* and are relatively eutrophic compared to upland rivers in the same regions. It is therefore not surprising that the *M. durrovensis* form is in the lower range of maximum size and size cannot be regarded as a diagnostic character.

Thickness and Weight of Shell: Fig. 1 and Table 3 summarise comparisons of shell thickness for the populations studied.

The data presented do show that the *M. durrovensis* form is thick-shelled, especially when compared to typical forms from soft water rivers such as the Derreen, Owenea, Spey and Kerry. However, compared with shells from intermediate hard water rivers, such as the Blackwater, Usk and Wye, the differences are much less and from our data not significant at the 95% level.

Table 2. Maximum lengths (Max. L. in millimetres) known for nine populations of *Margaritifera margaritifera*

Population	Max. L. mm	Population	Max. L. mm
Wye	93	Spey	112
Suir	100	Kerry	112
Usk	104	Derreen	119
Nore	104	Owenea	150
Blackwater	110		

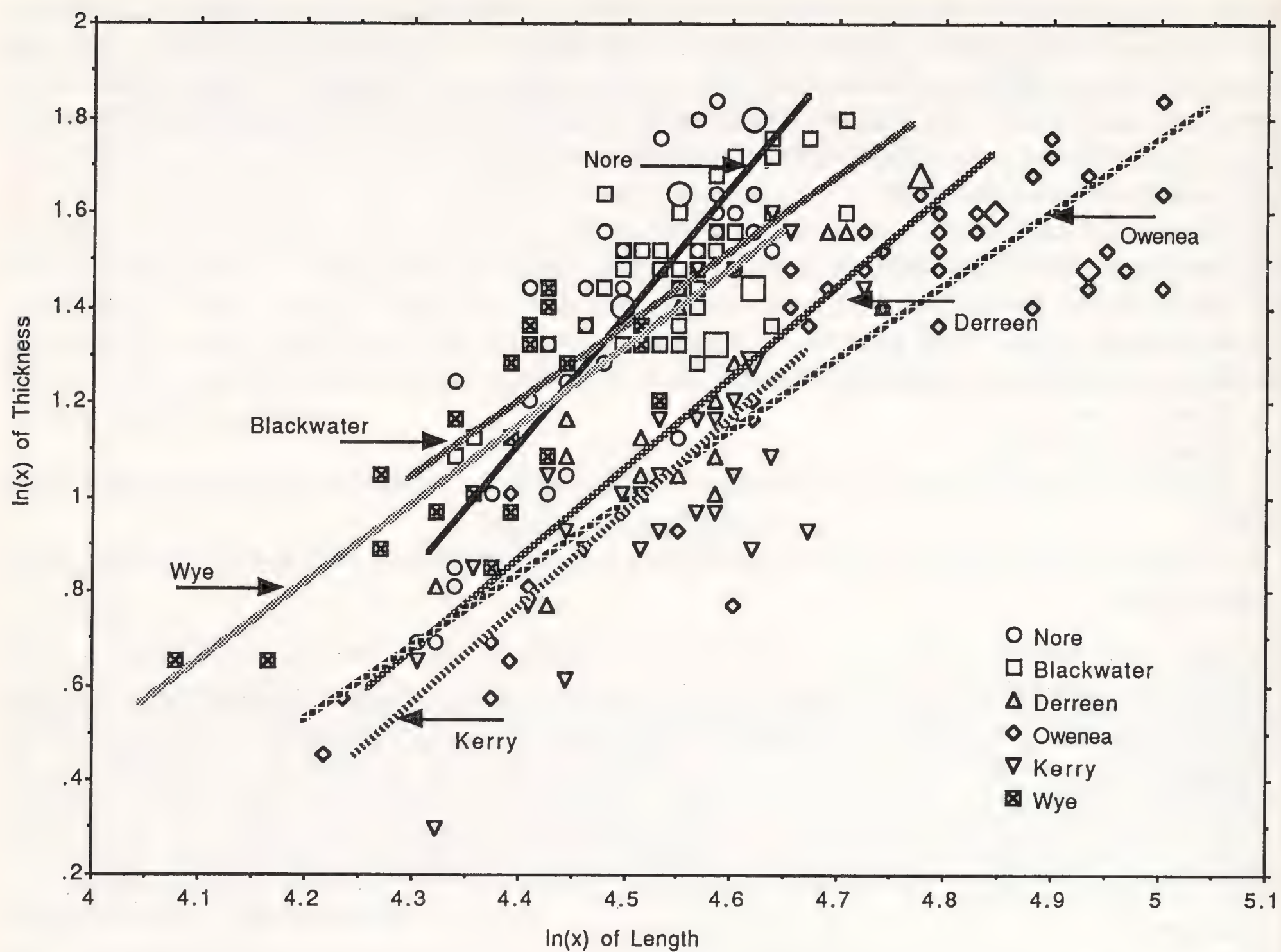


Fig. 1. Graphs of shell thickness against length for 5 populations of *Margaritifera margaritifera*. Both axes converted to natural logarithms.

Table 3. Length/Thickness statistical data derived from Anova computations. h = hard water; i = intermediate hard water; s = soft water.

Population	Count (N)	Mean Length ÷ Thickness	Std. Dev.	Std. Error	Scheffe F test *significant at 95% Nore vs. Others
Nore (h)	40	23.013	5.649	0.893	—
Suir (h)	3	27.172	6.324	3.651	0.203
Blackwater (i)	41	22.178	3.242	0.506	0.059
Wye (i)	20	26.213	4.105	0.918	0.573
Usk (i)	6	23.789	1.803	0.736	0.013
Derreen (s)	19	29.108	4.996	1.146	2.011*
Spey (s)	30	30.642	5.402	0.986	4.189*
Owenea (s)	43	30.155	6.206	0.946	4.439*
Kerry (s)	30	33.335	7.531	1.375	7.669*

Similar results were also derived from the shell weight data and these are presented in Fig. 2 and Table 4. It should be noted that for these data the similarity of pattern is best shown when the computations are done on a restricted range of lengths between 80 and 110 mm. The total size range of specimens included in our data set are generally exclusive of

small shells primarily because these are rare in the populations. Many parameters of bivalve shells display allometric growth and this is so for shell weight therefore shells of the maximum size (=length) will be disproportionately heavier. Consequently maximum size (=length) shells of the Nore population will be much heavier than similar sized shells from a population with a larger maximum size (=length) such as the Owenea.

Shell decortication: Decortication or erosion of the umbonal region of the shell is a typical feature of *M. margaritifera* and the *M. durrovensis* form is unusual in showing no traces of it. Decortication in *M. margaritifera* specimens is present and very marked even in those shells from relatively hard waters, such as the Blackwater and Usk. Compared with the Nore, Suir and Barrow, these latter rivers have a much lower calcium content and a mean pH under 8.0. However we have no information on the detailed effects of water chemistry on shell dissolution or the effects of sediment and surface micro-organisms on the pH of the shell micro-habitat.

Lunule: In all typical populations, where there is considerable decortication, the lunule is indistinct or apparently absent. In *M. durrovensis*, which has no umbonal erosion, the lunule is distinct but this also applies to populations of typical *M. margaritifera* where erosion is slight as shown by some specimens from the Dereen (Plate 1). The expression of the lunule is therefore directly related to the extent of umbonal erosion.

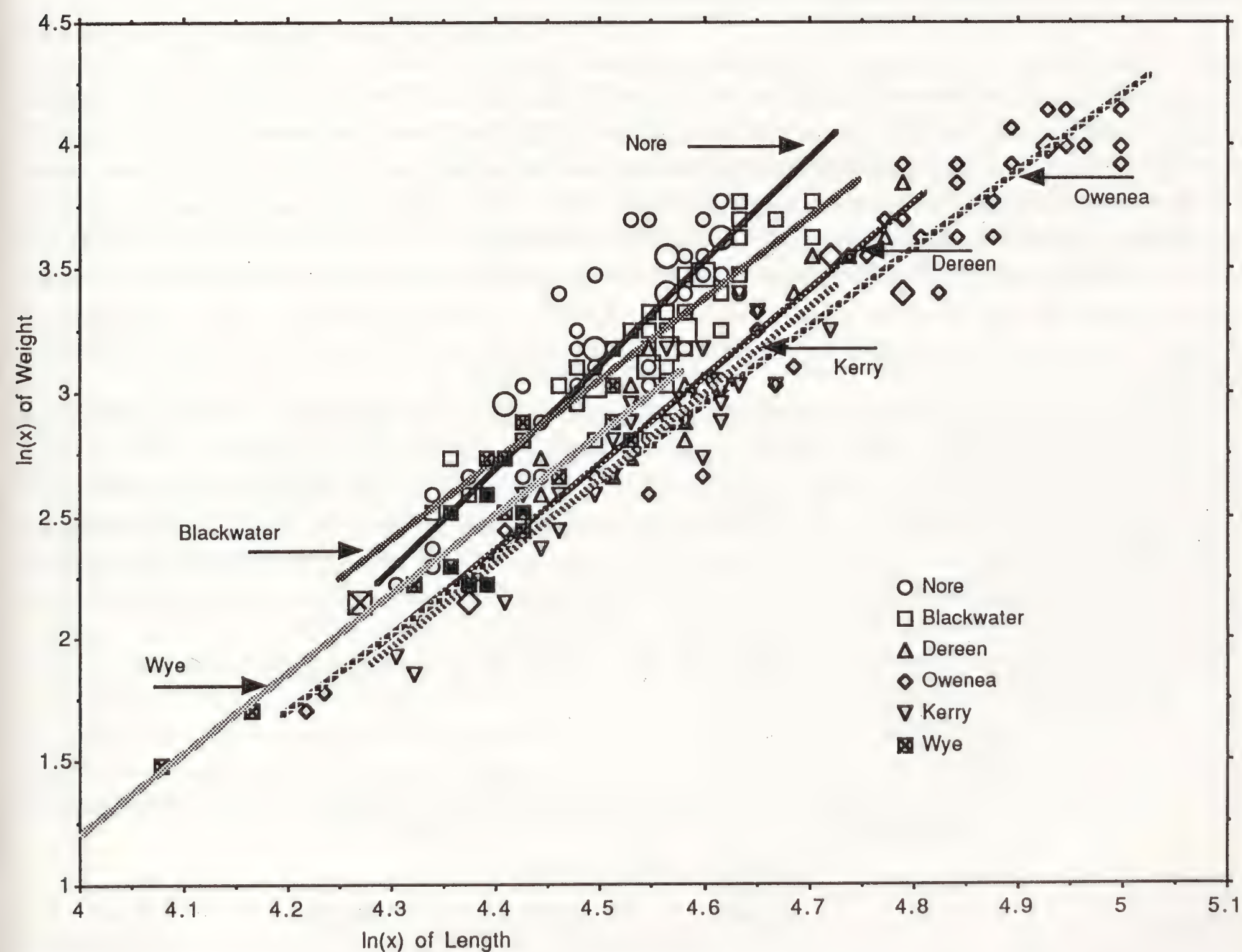


Fig. 2. Graphs of shell weight against length for five populations of *Margaritifera margaritifera*. Both axes converted to natural logarithms.

Table 4. Length/Weight statistical data derived from Anova computations. h = hard water: i = intermediate hard water: s = soft water.

Population	Count (N)	Mean Length ÷ Thickness	Std. Dev.	Std. Error	Scheffe F test *significant at 95% Nore vs. Others	F test as previous column but with range of length 80 –110 mm
Nore (h)	40	4.060	1.594	0.252	—	
Suir (h)	3	4.496	1.051	0.607	0.017	0.277
Blackwater (i)	41	3.929	0.898	0.140	0.011	0.150
Usk (i)	6	4.355	1.424	0.581	0.140	0.376
Wye (i)	20	7.246	2.387	0.534	4.241	5.683*
Derreen (s)	19	5.073	1.669	0.383	0.414	3.445*
Owenea (s)	43	4.470	2.559	0.39	0.109	4.888*
Spey (s)	30	6.657	2.614	0.447	3.625*	5.996*
Kerry (s)	30	6.024	1.980	0.362	2.110*	6.935*

Curvature of hinge plate: Plate 2 shows internal views of *M. margaritifera* and *M. durrovensis* and it is clear from these that the curvature of the hinge plate and angle of the pseudocardinal teeth shows a continuous variation. The progression of increasing angle is for the sequence Kerry-Owenea-Derreen-Nore-*M. auricularia marocana* (Pallary 1918) and this coincides with increasing shell thickness and lack of decortication.

Muscle scars: Various references to muscle scars are cited by Phillips (1928) which point out the apparent greater impression of the scars in *M. durrovensis*. From subjective observation this appeared to us to be related to shell thickness such that the scars were deeper in larger especially gerontic specimens within a population and were deeper in those populations with thick shells. To test the latter a comparison of the Nore (*M. durrovensis*) and Blackwater (*M. margaritifera*) populations was made. A scar impression index was measured for the anterior adductor by measuring the difference between the thickness of the shell at the posterior edge of the scar and at the anterior edge of the scar. Table 5 shows that there was no significant difference between these populations and indeed that from the Blackwater had a deeper mean index.

Similar observations were made for both the extent of rugose sculpturing of the adductor scars and the expression of the ridge separating the posterior pedal retractor. There was increasing rugosity and a more developed ridge in thicker shells in all populations but size for size the shells from the Nore, Blackwater and Usk displayed these features most strongly.

To assess the relative size of the adductor scars two ratios were measured, the relative size of the adductor scars to each other (PA/AA) and the size of the posterior adductor to the length of the shell (L/PA). The comparisons are shown in Tables 6–7.

Although Phillips (1928) states that in *M. durrovensis* the posterior adductor is 1.5× larger

Table 5. Comparison of anterior adductor scar impression (SI Index) for populations from the Nore and Blackwater. h = hard water: i = intermediate hard water

Population	Count (N)	Mean SI Index	Std. Dev.	Std. Error	F stats Data
Nore (h)	31	36.873	8.591	1.543	0.937
Blackwater (i)	34	35.004	6.97	1.195	p=0.34

Table 6. Comparison of relative size of adductor scars (PA/AA) for populations from the Nore, Blackwater and Kerry. h = hard water; i = intermediate hard water; s = soft water

Population	Count (N)	Mean PA/AA	Std. Dev.	Std. Error	Scheffe F test *significant at 95%
Nore (h)	31	1.317	0.094	0.017	—
Blackwater (i)	34	1.378	0.109	0.019	2.968E ⁻⁵
Kerry (s)	28	1.317	0.101	0.019	2.708

Table 7. Comparison of size of the posterior adductor scar to shell length (L/PA) for populations from the Nore and Blackwater. h = hard water; i = intermediate hard water

Population	Count (N)	Mean L/PA	Std. Dev.	Std. Error	F stats Data
Nore (h)	31	4.989	0.248	0.045	1.04
Blackwater (i)	34	4.918	0.309	0.053	p=0.31

than the anterior but only slightly larger in typical *M. margaritifera* we find no supporting evidence. Indeed the largest ratio is for the Blackwater population but this is not significant at the 95% level.

Comparing the size of the posterior adductor to the shell length yielded no significant results as can be seen from Table 7.

Juvenile shell with wavy rugae coincident with growth lines and not drawn out on the gonial slope: We have examined over one hundred shells of *M. durrovensis* and are unable to confirm this observation in any shell other than that illustrated in the original description. As with many other populations of pearl mussels we were unable to find any juveniles of *M. durrovensis* in the Nore. The shape of the juvenile shell is taken from its appearance on the uneroded adult and we believe that wear caused the atypical appearance in the figured specimen.

Conclusions

Our review of shell morphology shows that the only significant difference in the shell of *M. durrovensis* is that it is uneroded. Although it also possesses perhaps the heaviest and thickest shell when compared with other intermediate hard water populations this is not greatly significant. It is evident from this that *M. durrovensis* is placed at the end of a gradation which is apparently related to shell thickness and hence probably to water chemistry. Increasing shell thickness and lack of decortication are related to the expression of the hinge, lunule and muscle scar features. The most interesting feature is the presence of decortication in those mussels from intermediate hard water such as the Usk and Blackwater. It is necessary to discover whether the lack of decortication in *M. durrovensis* is related to some threshold effect, or localised micro-habitat pH, or whether indeed there is some genetic component. However in all other aspects of shell morphology we are led to the conclusion that the *M. durrovensis* shell form is ecologically controlled and we are inclined to agree with Haas (1948) that *M. durrovensis* is the “lime phase of *M. margaritifera*”.

SHELL STRUCTURE

Introduction

Shells of unionids are unusual in containing internal conchiolin layers that are believed to prevent the dissolution of the shell in acidic waters after the periostracum is worn away or

damaged (Tevesz & Carter 1980, Kat 1983). It is thought that these bivalves, especially those with thin shells, from very acidic habitats, in which they suffer more severely from dissolution effects, produce greater numbers of conchiolin layers. Kat (1983) analysed the microstructure of the conchiolin layers within the shell of North American Unionoidea to determine whether any species-specific characteristics existed. His results showed that Margaritiferidae, unlike the Unionidae, possessed only one type of internal conchiolin layer, which was divisible into three distinct regions and similar in ultrastructure to the periostracum. He was also able to recognise species differences in the relative proportions of these layers between *M. margaritifera*, *M. falcata* and *Cumberlandia monodonta*. In this paper we attempt to use Kat's methods to analyse possible differences between *M. durrovensis* and typical *M. margaritifera*.

Materials and methods

Shells from the rivers Owenea, Blackwater, Derreen and Nore in Ireland and the Kerry in Scotland were used for the analysis. In preparation for SEM, a single valve from each locality was embedded in clear plastic, radially sectioned with a circular rock saw, polished with carborundum grit and etched for five seconds with 5% HCl. During SEM the specimens were tilted sufficiently to reveal the microstructure of the reticulate portions of the conchiolin layers. This process slightly distorts the relative thickness of the uppermost homogeneous region of the conchiolin layers.

Results

Internal conchiolin layers were found in all shells examined but the number varied i.e. Kerry – 8; Owenea – 3; Derreen – 2; Blackwater – 2; Nore – 1.

Kat identified three regions in the conchiolin layers of *M. margaritifera* namely an outermost homogeneous region about 10–16 μm thick which surmounts a vacuolated region about 10–20 μm thick. Underneath this is the innermost region of widely spaced organic lamellae interspersed with blocks of subprismatic shell material. This is the thickest region at about 15–40 μm . The conchiolin layers in this study were of a similar structure but there was considerable variation in the thickness of the vacuolated and inner lamellar layers within individual shells. In the Kerry shell there were also layers which consisted of the homogeneous layer only and in others the thickness of the two inner regions was variable (Fig. 3a–c). A similar variation was found in the Blackwater shell (Fig. 3e–f). In the Nore shell (Fig. 3h) the three layers are present but the two inner regions are relatively narrow with small vacuoles and closely spaced organic lamellae. In this respect there is a similarity with the Derreen shell (Fig. 3g) and with one of the layers from the Blackwater shell (Fig. 3f).

Discussion

The structure of the conchiolin layers is illustrated in Fig. 3 is consistent with that described by Kat (1983) but is more variable. The vacuolated and lamellar layers vary greatly in thickness and may be absent. The resulting single homogeneous layer is however not equivalent to the single homogenous thin layers found in unionids. Unfortunately Kat did not carry out an intraspecific analysis of any margaritiferid species but did show considerable inter-population differences for *Elliptio complanata*. Kat considered that these differences could be explained by the rapid radiation that this species had undergone (Kat 1984) but he does not appear to have considered any ecological controls over layer morphology. The range of layer morphology exhibited by *M. margaritifera*, *M. falcata* and *Cumberlandia* is not great (Kat 1983) and is encompassed by the variation presented from our results on *M. margaritifera* alone. We suggest that just as the number of layers formed is affected by dissolution rates then the dissolution pressure and growth rate could equally affect the layer morphology. There is nothing in our results to suggest that the layer

morphology seen in *M. durrovensis* is any more different than that seen between populations of *M. margaritifera*. Our results do not challenge the family level differences listed by Kat (1983) but do cast doubt upon the use of the conchiolin layers as a species level character in the margaritiferids. The numbers of inner conchiolin layers observed is consistent with the belief that they are deposited in response to shell dissolution. The Kerry shell is the thinnest, is heavily eroded and has the most layers whereas the Nore shell is very thick, is uneroded and has only a single layer. Our results equate well with those of Kat (1983) for *Elliptio complanata*.

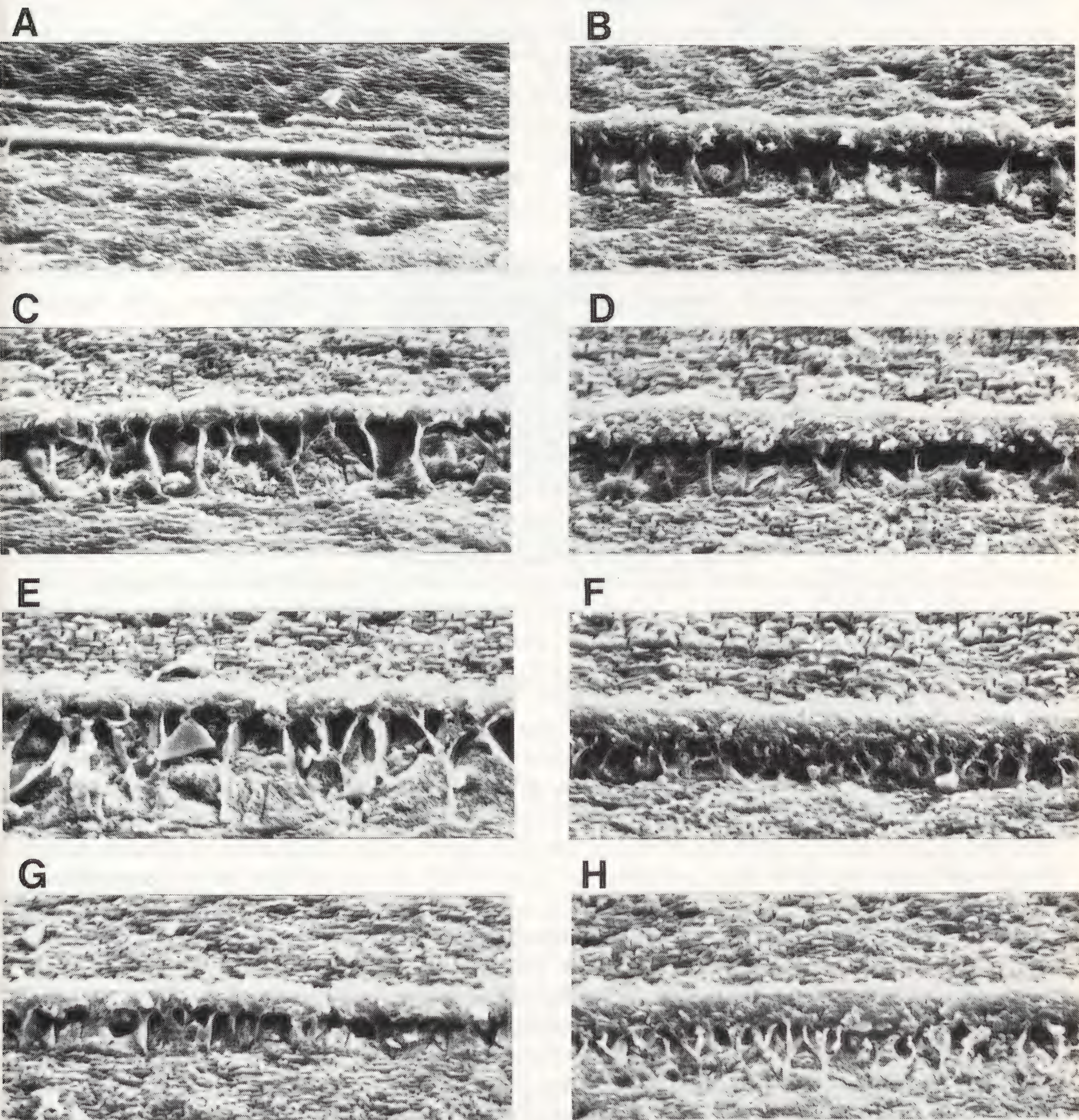


Fig. 3. Conchiolin layers in shells of *Margaritifera* from:— A, B, C — Kerry, Scotland, D — Owenea, Ireland, E, F — Blackwater, Ireland, G — Derreen, Ireland, H — Nore, Ireland.

Introduction

Bloomer (1928) considered that the anatomy of *M. durrovensis* closely corresponded with Ortmann's description of the anatomy of *M. margaritifera* (Ortmann 1912), except in relation to the larger size of the muscles, the shape of the foot which is divided by a furrow, the colour of parts of the foot and branchial fringes (tentacular processes) and the length of gills. He noted the 'horizontal ridge', incompletely separating the branchial from the supra-branchial chamber.

In a subsequent paper, Bloomer (1932) compared the anatomy of *M. margaritifera* from a number of localities in Ireland, Scotland and England. He again noted the lack of any essential anatomical differences between *M. margaritifera* and *M. auricularia* and listed the characters important in classification as:

1. The shape and structure of the gills 2. The shape and extent of the branchial and anal apertures 3. the connection of the gills with the sides of the visceral mass and the mantle 4. the shape and attachment of the labial palps 5. the line of mantle attachment.

The stomach anatomy of three species of N. American margaritiferids, including *M. margaritifera*, was described by Smith (1986) who found species-specific differences between them.

Following these previous studies, we have compared *M. durrovensis* with *M. margaritifera*, from Ireland, Wales and N. America, stressing features of the musculature, gills, mantle margins and alimentary canal.

Results

The gross morphology of *M. durrovensis* (Nore) and *M. margaritifera* (Blackwater) are illustrated in Figs. 4A and 4B. Both are in agreement with previous descriptions by Ortmann (1912), Heard (1974) and Smith (1979, 1980).

The surface features of the muscles are obviously related to the muscle impression on the shell and the amount of rugose sculpture on the scars. It has already been shown in this paper that these features are variable and do not consistently characterise *M. durrovensis*. The relative size of the adductor and pedal retractor muscles has also been shown above (see shell morphology) to be variable and not a useful discriminant character.

The gills of both are of the same structure with the outer demibranch being a little smaller. All demibranchs are fused posteriorly and held in position *in vivo* by the anal fold (horizontal ridge) of the mantle and thus form separate inhalent and exhalent chambers. The interlamellar fusion by septae is variable and is always rather irregular but has an underlying diagonal arrangement. Figs. 5a-d illustrate the septation of the inner demibranch of specimens from four rivers namely the Nore, Blackwater, Spey and Kerry. There is a tendency for some to show more dense, more elongate septae (especially in those from the Blackwater) but we have found no obvious relationship to environmental or geographical parameters.

The labial palps have a simple arrangement of sorting ridges which in both *M. margaritifera* and *M. durrovensis* number about 120 (Fig. 6). The mantle margin is free along its total length and bears papillae only on the postero-ventral margin which corresponds with the inhalent aperture. The papillae are extensions of the inner mantle fold and take the form of short digitate processes each with a terminal finger and two to four pairs of rounded lateral extensions. This structure was the same for all specimens examined (Nore, Blackwater, Owenea, Derreen, Usk, Kerry and Spey). The anal ridge takes the form of an inrolled flap of tissue running from the region below the anus adjacent to the posterior adductor horizontally to the posterior point of the mantle edge. The form was identical in all

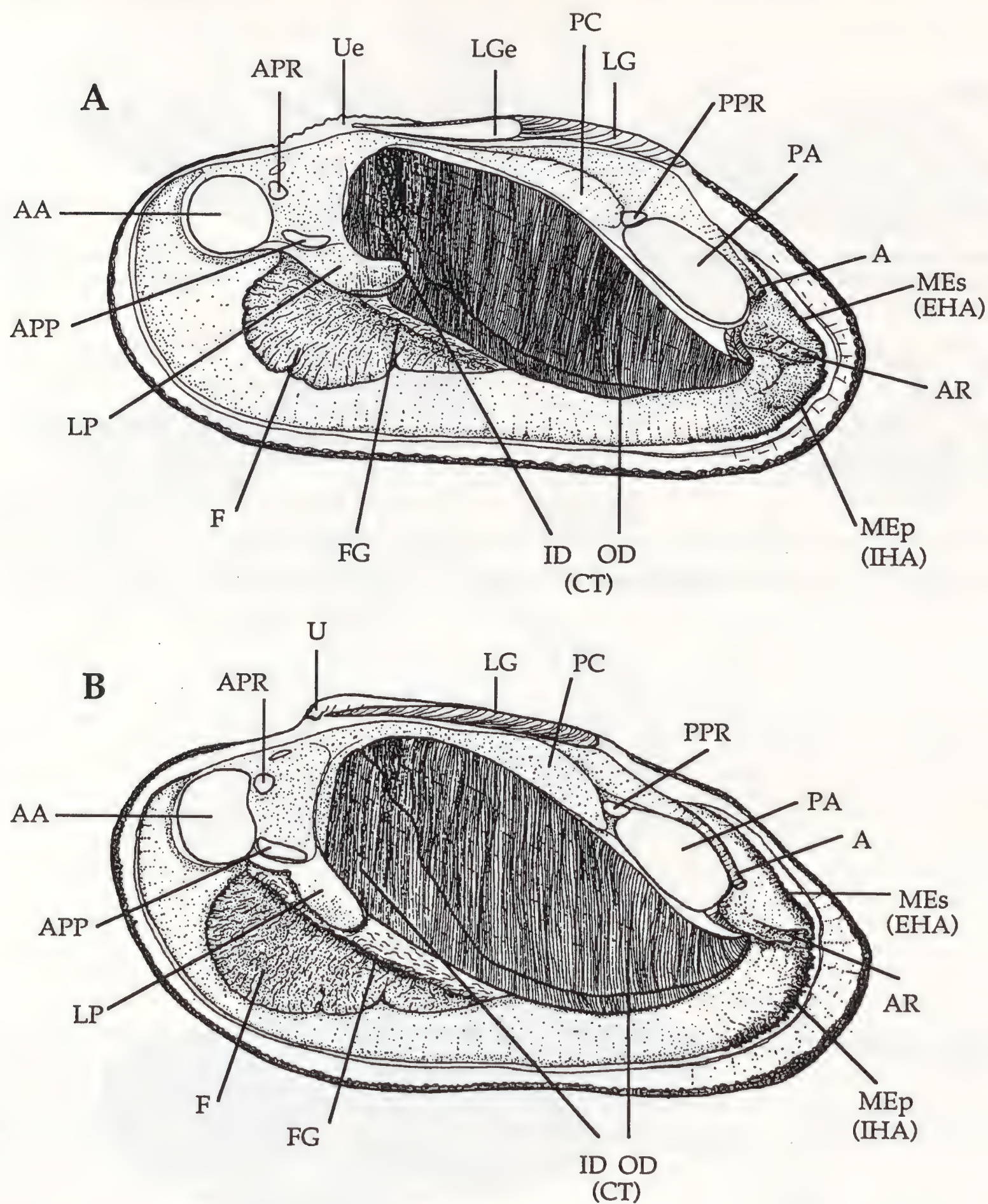


Fig. 4. Gross anatomy viewed after the removal of the left valve and mantle. **A.** *M. margaritifera* from the Blackwater. **B.** *M. durrovensis* from the Nore.

A – anus, AA – anterior adductor, APR – anterior pedal retractor, AR – anal ridge (horizontal ridge), F – foot, FG – foot groove, ID – inner demibranch (ctenidium), LG (e) – ligament (eroded), LP – labial palp, MEp (IHA) – papillate mantle edge (inhalent aperture), MEs (EHA) – smooth mantle edge (exhalent aperture), OD – outer demibranch (ctenidium), PA – posterior adductor, PC – pericardium, PPR – posterior pedal retractor, U (e) – umbo (eroded)

specimens studied although it was apparently less pronounced in the mussels from the Kerry. The mantle edge along the exhalent aperture is not papillate but is thicker than on the ventral and anterior margins. The anus, mantle edge, anal ridge and the borders of the exhalent and inhalent apertures are heavily pigmented. The colours are black to chocolate brown with paler spots, but their intensity varies from population to population, with Nore mussels being very dark (Fig. 7A–B). The foot is demarcated from the visceral mass by a distinct groove which is marked by a change of pigmentation. In mussels where the foot pigmentation is strong (Nore and Usk) the groove appears to be deeper but this is an illusion.

The alimentary canal (Fig. 8A) was dissected out of the visceral mass and is the same in the Nore, Blackwater and N. American specimens examined. The illustrations are from

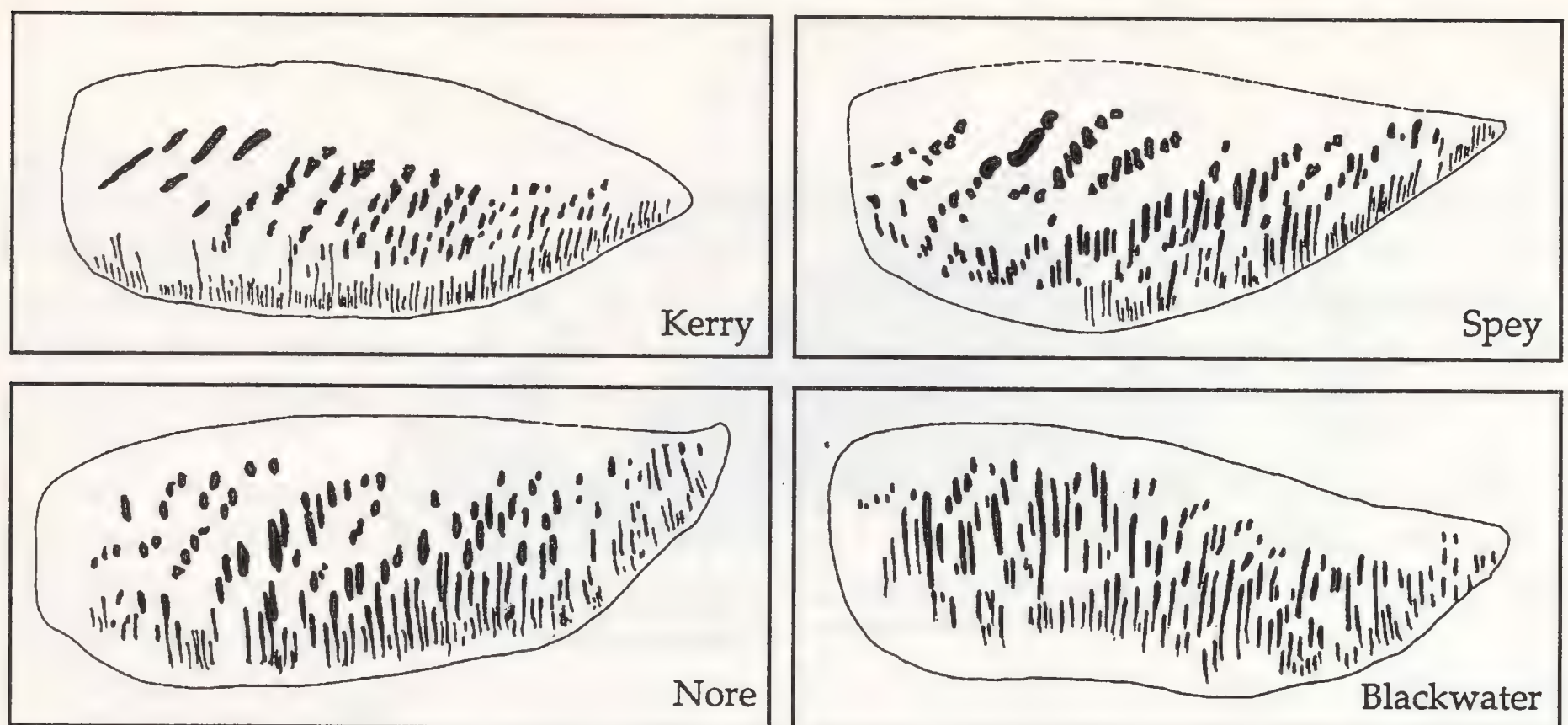


Fig. 5. Diagrams to illustrate the septum patterns of the inner demibranch of mussels from four rivers.

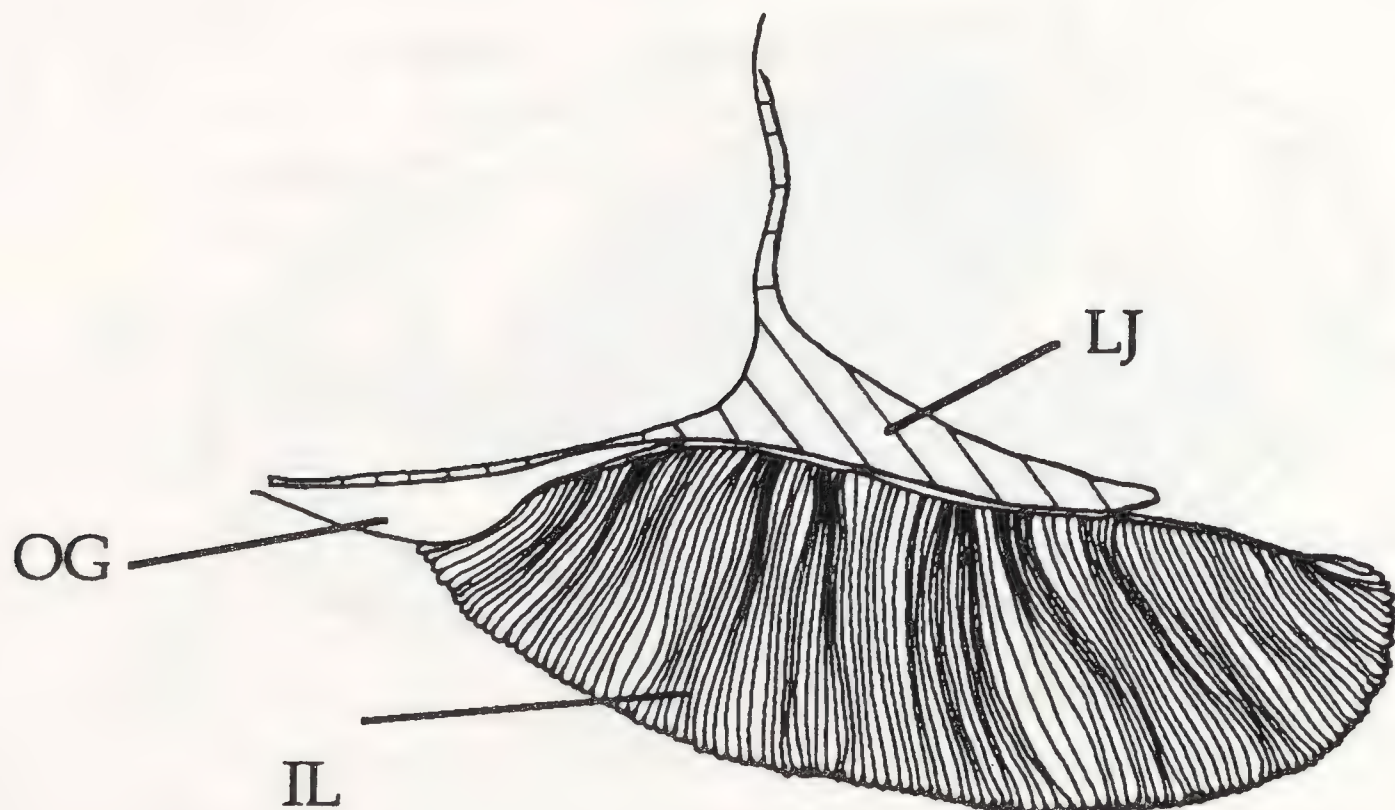


Fig. 6. Inner lamella of labial palp of *M. durrovensis* from the River Nore. IL—inner lamella of labial palp, LJ—junction of the lamellae of labial palp, OG—oral groove.

specimens of *M. durrovensis*. The oesophagus is short and enters the stomach high on its anterior face. The conjoined midgut and style sac leaves the stomach ventrally and the midgut passes in a diagonal path posteriorly deep into the heel of the foot. Here it bends back upon itself in a long loop returning close to the base of the stomach before looping again back into the heel of the foot where it curves dorsally into the hind gut. The hind gut is large with a deeply folded crescentric lumen and runs dorsally before curving posteriorly behind the stomach. In this dorsal position it passes into the rectum running through the pericardium and over the posterior adductor muscle to the anus.

The stomach was dissected free of the surrounding tissue and is shown from the left side in Fig. 8 and from the dorsal in Fig. 9B. The features seen are four primary digestive diverticula ducts: Left DDD^L , left anterior DDD^{LA} , right anterior DDD^{RA} and right DDD^R . The oesophagus is in a median anterior-dorsal position. Across the anterior roof is a crescentric area bulging above the left of the oesophagus, sorting ridges are apparent through the wall of this area. There are two principal sorting areas on the roof (PSR), the

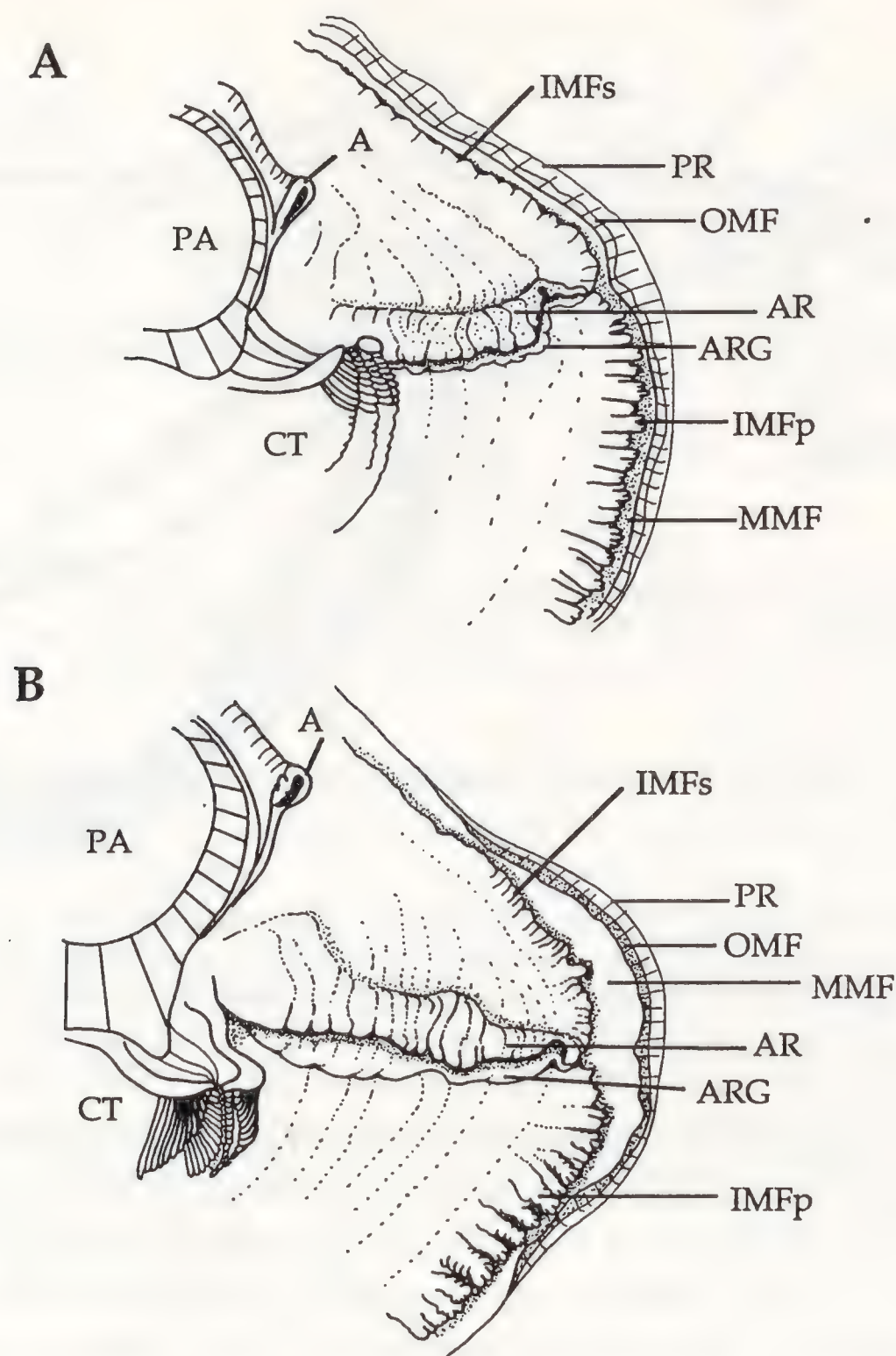


Fig. 7. Posterior mantle margins showing disposition of anal ridge and mantle edge strictures. **A.** *M. margaritifera* from the Blackwater. **B.** *M. durrovensis* from the Nore.

A – anus, AR – anal ridge (horizontal ridge), ARG – anal ridge groove (horizontal ridge groove), CT – ctenidium, IMFp – inner mantle fold (papillate), IMFs – inner mantle fold (smooth), MMF – middle mantle fold, OMF – outer mantle fold, PA – posterior adductor, PR – periostracum

anterior extends slightly along the wall of the oesophagus. There is a transverse ridge (TR) demarcating the oesophagus but anterior sorting ridges were not observed. To the left and slightly below the roof sorting area lies a smaller bulge which projects anteriorly. This is the dorsal hood tract. The ventral area is expansive and the conjoined style sac and midgut leave from the central region of the floor. The stomach was then opened by cutting through the hood tract and around the posterior edge of the roof sorting area and out through the right duct. This was then folded forward and viewed from above. Fig. 9 shows the anterior floor of the dissected stomach of a Nore mussel from this view. The major typhlosole (MT) bulges out of the floor with the pathways to the digestive ducts lying in front and to the right. There is a distinct right sorting area (RSA) which passes forward as a narrow tongue towards the oesophagus; then a smooth area anteriorly and then a smaller left sorting area (LSA)

Discussion

The analyses of the anatomy revealed that there were no species-significant differences between any of the mussels from the populations sampled. However this is not surprising given the small differences observed between other species of *Margaritifera* and the variation observed in them.

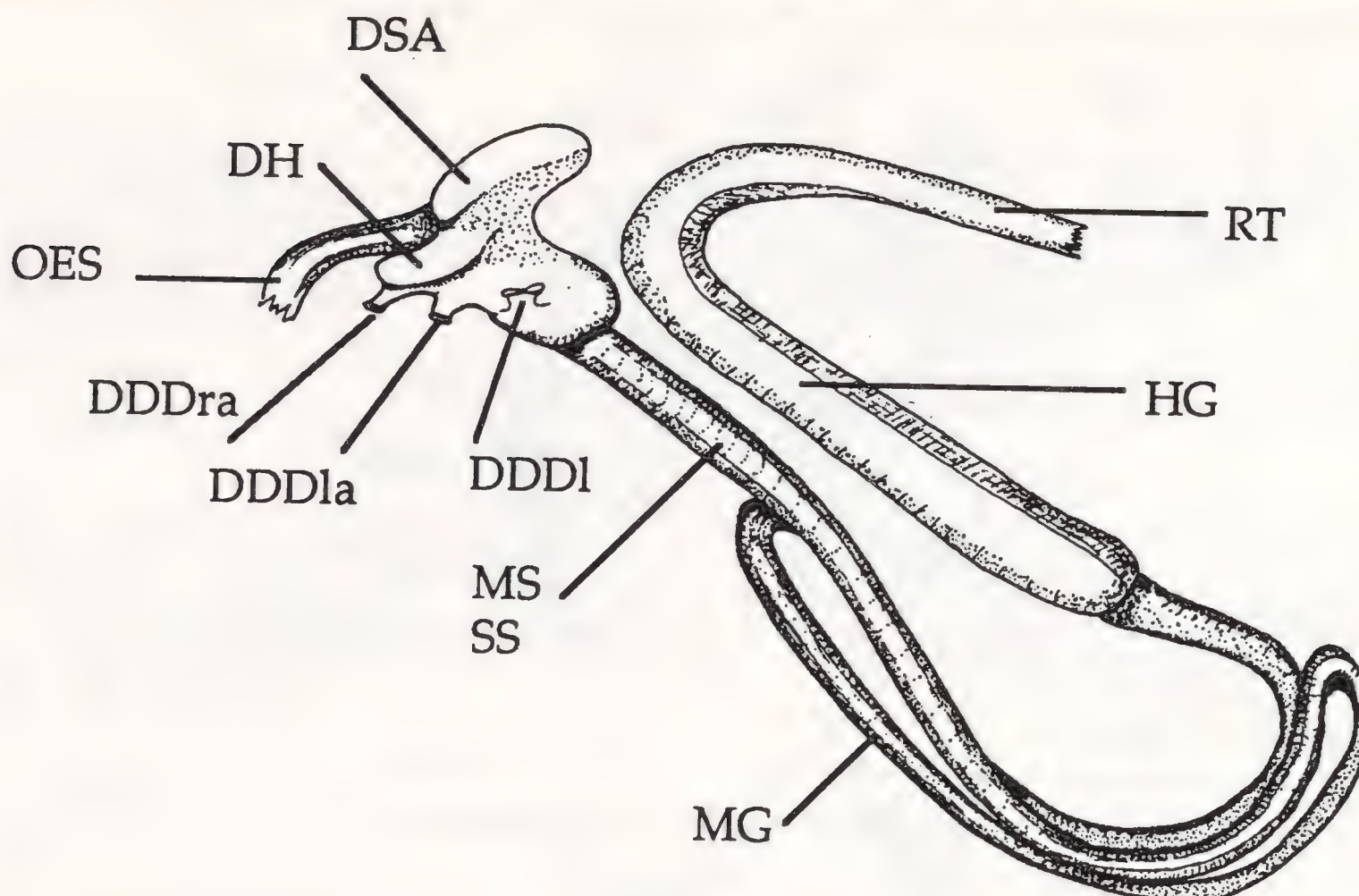


Fig. 8. The gut of *M. durrovensis*. External view of the gut after dissection from the left side.

DDDI – left digestive diverticula duct, DDDla – left anterior digestive diverticula duct, DDDr – right digestive diverticula duct, DDDra – right anterior digestive diverticula duct, DH – dorsal hood, DSA – dorsal sorting area, HG – hind-gut, MG (SS) – mid-gut (style sac), MG – mid-gut, OES – oesophagus, RT – rectum

Bloomer's (1927) comparison of the gills of various specimens led him to conclude that in those specimens from the Shetland Islands, Glengariff and Co. Clare the gills were more primitive than those from the Esk but that gills of specimens from the Rivers Nore and Wye were more advanced than gills from the Esk mussels. From his table it appears that in the Wye and Nore specimens there was a tendency to form longer interlamellar junctions, especially in the inner gill. Boycott (1927) noted the considerable variation in the distribution of gill septae and this study confirms his observations, but any possible functional significance for this or the underlying causes are not known.

Smith (1986) showed that differences existed in the expression of some of the sorting areas in the stomach both between species of margaritiferids and within populations of *M. margaritifera*. In the specimens dissected for this study no such differences could be found. Smith reported variation in the expression of an anterior sorting area at the junction with the oesophagus. This was not evident in any of the specimens examined here and this is in

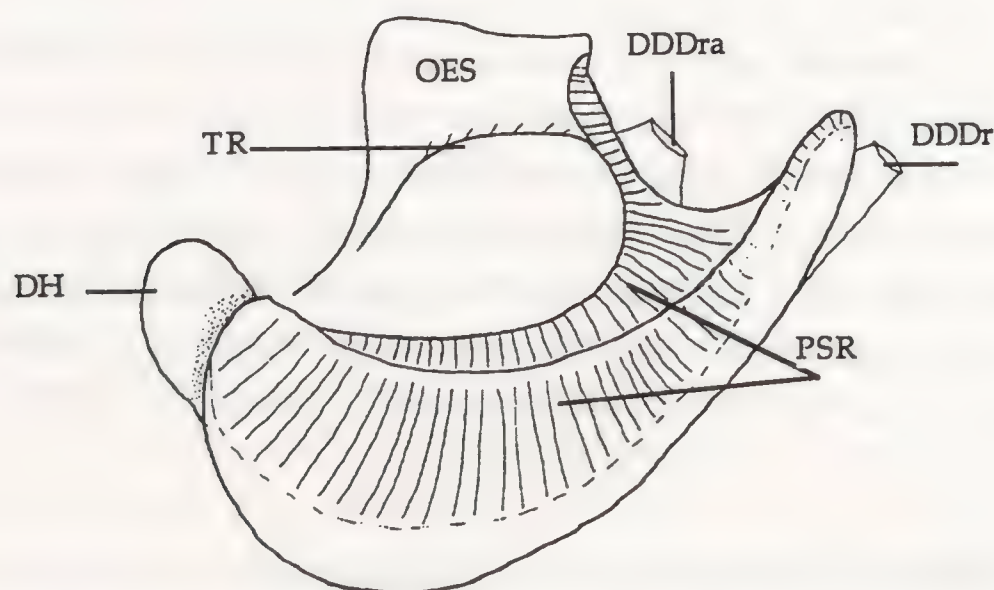


Fig. 9A. *M. durrovensis*. External, dorsal view of the stomach showing the sorting on the roof.

DDDr – right digestive diverticula duct, DDDra – right anterior digestive diverticula duct, DH – dorsal hood, OES – oesophagus, PSR – principal sorting areas of the roof, TR – transverse ridge

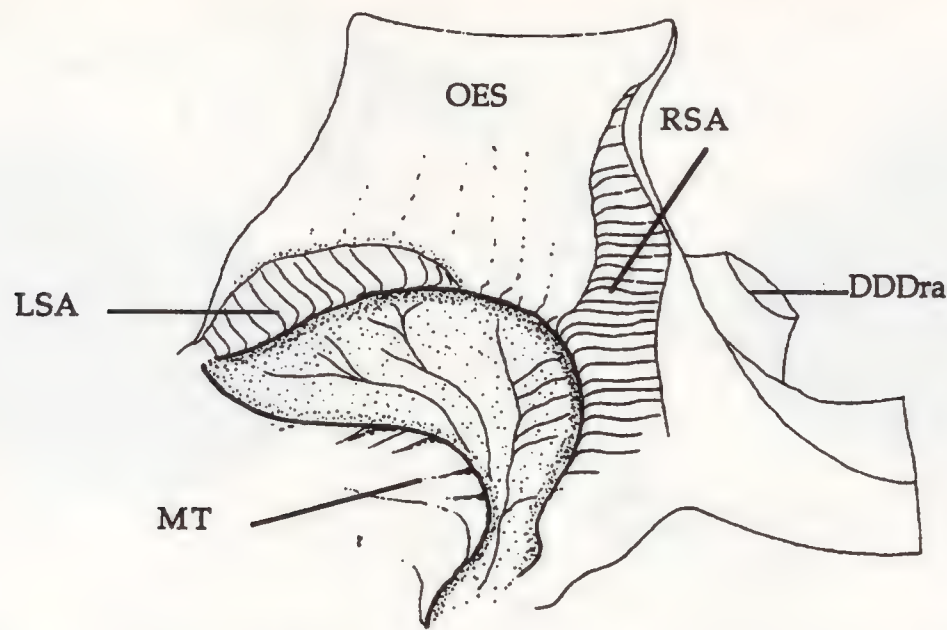


Fig. 9B. *M. durrovensis*. View of the anterior floor of the stomach after removal of the roof. DDDr – right digestive diverticula duct, DDDra – right anterior digestive diverticula duct, MT – major typhlosole, LSA – left sorting area, OES – oesophagus, RSA – right sorting area

keeping with some of Amercian specimens reported upon by Smith (1986). The right sorting area extends as a short tongue into the oesophagus in all specimens (Fig. 9A) but this is not represented in Smith's illustration. This may result from a different angle of view or variation in fixation may well cause differences in contraction of the tissues. As this feature is present in all the specimens that we examined we do not regard its absence in Smith's illustrations as significant.

This study also confirms variation in mantle and foot pigmentation between populations, but again no meaningful pattern has been found. In conclusion, as with the shell, but to a lesser degree, there is phenotypic variation in the anatomy between populations but we do not find that *M. durrovensis* shows any unique anatomical differences which would warrant giving it species status at present.

GENETIC ANALYSIS

Introduction

Various authors have shown that protein, RNA and DNA analysis can be used to discriminate between species or populations of freshwater mussels (Davis 1984, Kat & Davis 1984). A recent genetic analysis of many populations of *M. margaritifera* in the British Isles (Purser 1985) did not include *M. durrovensis* or any other Irish populations.

Materials

Samples from four Irish populations from the Owencarrew (1), Derreen (4), Nore (5) and Blackwater (7) and one North American (Pennsylvania) population were chosen for this analysis (Fig. 10). The Derreen, Nore and Blackwater are southern Irish rivers while the Owencarrew is in the north-west of the country. Only six mussels from each river were used because of their protected status in Ireland and because of the very low population size in the Nore. The shells and tissue samples from this part of our study have been deposited in the Academy of Natural Sciences, Philadelphia.

Methods

The specimens were collected in August, 1990 and the soft parts were extracted and immediately frozen in liquid nitrogen and subsequently flown to Philadelphia for analysis. Starch gel electrophoresis was used as described by Davis & Fuller (1981) and Davis (1984). There were 24 loci studied which yielded 27 alleles.



Fig. 10. Map of Ireland showing the river systems from which the samples of *M. margaritifera* were analysed – (1) Owencarrew, (2) Owenea, (3) Derreen (trib. of Slaney), (4) Barrow, (5) Nore, (6) Suir, (7) Blackwater.

PLATE 1

1. *Margaritifera auricularia* (Lamarck, 1819) Agen, River Garonne, France, 106 mm.
2. *Margaritifera auricularia marocana* Pallary, 1918 Fez, Morocco, 77 mm. Syntype.
3. *Margaritifera margaritifera* form *durrovensis* Phillips, 1928 River Nore, Ireland, 90 mm.
4. *Margaritifera margaritifera* (Linnaeus, 1758) River Derreen, Ireland, 93 mm.
5. *Margaritifera margaritifera* (Linnaeus, 1758) River Usk, Wales, 98 mm.
6. *Margaritifera margaritifera* (Linnaeus, 1758) River Blackwater, Ireland, 94 mm.
7. *Margaritifera margaritifera* (Linnaeus, 1758) River Owenea, Ireland, 148 mm.
8. *Margaritifera brunneus* (Bonhomme, 1840) River Viaur, France, 85 mm. Syntype.
9. *Margaritifera margaritifera* (Linnaeus, 1758) River Kerry, Scotland, 100 mm.
10. *Margaritifera margaritifera* (Linnaeus, 1758) River Spey, Scotland, 102 mm.



1



2



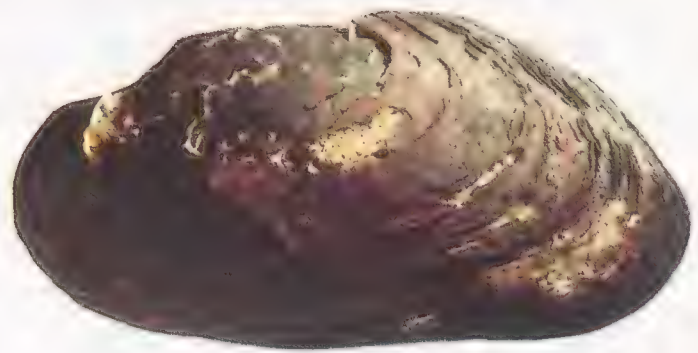
3



4



5



6



7



8



9



10

Analysis of the results was limited by the small sample size so that population genetics using F statistics and Hardy-Weinberg methods were not appropriate. The sample size, given the low heterozygosity found, is however adequate to analyse genetic distances. Four distance measurements were made namely, standard Nei's (Nei 1972), modified Rogers' (Wright 1978) and 'Arc' and 'Chord' (Cavalli-Sforza & Edwards 1967). These and a Wagner tree were computed using the analytical package BIOSYS-1 (Swofferd & Selander 1981, Davis *et al.* 1988).

Results

Table 8 lists the allelic frequencies at the 24 loci studied for each of the five populations. It shows that only one allele (PGM-1) was polymorphic and that fixation for alternate alleles between the Irish populations and the Pennsylvanian population occurred at two loci, Isdh-I and Isdh-II.

The number of polymorphic loci (P) and values for mean heterozygosity (H) are very low and are summarised in Table 9.

Tables 10–12 give the matrices of genetic distance and or genetic identity for the three methods – Nei's, modified Roger's and Arc/Chord – used. All three procedures give similar results showing that:

- 1. The genetic distances are all very small.
- 2. That the Irish populations are more similar to each other than they are to the Pennsylvanian population.

From the Rogers' and Arc/Chord matrices cluster analyses were performed to produce cophenetic matrices and from these the phenograms were constructed. They all gave very similar results and are represented in Fig. 11 by that based on the Rogers' distance. These are again similar and show graphically the results listed above but further reveal that:

Table 8. Showing frequency of alleles at the 24 enzyme loci studied with those showing variation outlined by dotted lines, namely ISDH1, ISDH2 and PGM1. All sample sizes were of 6 individuals.

Locus	Blkw'	Derr'	Nore	O'car	Penn'	Locus	Blkw'	Derr'	Nore	O'car	Penn'
MPI						AAT1					
A	1.000	1.000	1.000	1.000	1.000	A	1.000	1.000	1.000	1.000	1.000
GPI						AAT2					
A	1.000	1.000	1.000	1.000	1.000	A	1.000	1.000	1.000	1.000	1.000
MDH1						GDH					
A	1.000	1.000	1.000	1.000	1.000	A	1.000	1.000	1.000	1.000	1.000
MDH2						CK					
A	1.000	1.000	1.000	1.000	1.000	A	1.000	1.000	1.000	1.000	1.000
LAP1						6PGD					
A	1.000	1.000	1.000	1.000	1.000	A	1.000	1.000	1.000	1.000	1.000
LAP2						SOD					
A	1.000	1.000	1.000	1.000	1.000	A	1.000	1.000	1.000	1.000	1.000
OCT						ISDH1					
A	1.000	1.000	1.000	1.000	1.000	A	1.000	1.000	1.000	1.000	1.000
ME						B	0.000	0.000	0.000	0.000	1.000
A	1.000	1.000	1.000	1.000	1.000	ISDH2					
CAT						A	1.000	1.000	1.000	1.000	0.000
	1.000	1.000	1.000	1.000	1.000	B	0.000	0.000	0.000	0.000	1.000
HEX						PGM1					
	1.000	1.000	1.000	1.000	1.000	A	0.333	0.917	0.833	0.500	0.000
NADD						B	0.677	0.083	0.167	0.500	1.000
	1.000	1.000	1.000	1.000	1.000	PGM2					
aGDPH						A	1.000	1.000	1.000	1.000	1.000
	1.000	1.000	1.000	1.000	1.000	PGM3					
G3PDH						A	1.000	1.000	1.000	1.000	1.000
	1.000	1.000	1.000	1.000	1.000						

Table 9. The percentage of polymorphic loci (P) and mean heterozygosity (H) for the five populations sampled

Population	Mean sample size per locus	Mean number of alleles per locus	Percentage of polymorphic loci (P)	Mean heterozygosity (H)		
				Direct Count	Hdy Wbg	Exp.
Blackwater	6.0	1.0	4.2	0.014		0.020
Derreen	6.0	1.0	4.2	0.007		0.007
Nore	6.0	1.0	4.2	0.000		0.013
Owencarrew	6.0	1.0	4.2	0.014		0.023
Pennsylvania	6.0	1.0	0.0	0.000		0.000

Table 10. Matrix of Nei's genetic distance (below diagonal line) and Nei's genetic identity (above diagonal line)

Population		1	2	3	4	5
Blackwater	1	*****	0.987	0.991	1.000	0.912
Derreen	2	0.013	*****	1.000	0.994	0.882
Nore	3	0.009	0.000	*****	0.997	0.888
Owencarrew	4	0.000	0.006	0.003	*****	0.906
Pennsylvania	5	0.092	0.126	0.119	0.099	*****

Table 11. Matrix of modified Rogers' genetic distance

Population		1	2	3	4	5
Blackwater	1	*****	*****	*****	*****	*****
Derreen	2	0.119	*****	*****	*****	*****
Nore	3	0.102	0.017	*****	*****	*****
Owencarrew	4	0.034	0.085	0.068	*****	*****
Pennsylvania	5	0.297	0.334	0.335	0.306	*****

Table 12. Matrix of arc distance (below diagonal line) and chord distance (above diagonal line)

Population		1	2	3	4	5
Blackwater	1	*****	0.085	0.069	0.022	0.272
Derreen	2	0.086	*****	0.017	0.063	0.303
Nore	3	0.069	0.017	*****	0.047	0.296
Owencarrew	4	0.022	0.064	0.047	*****	0.278
Pennsylvania	5	0.300	0.333	0.325	0.306	*****

1. On a genetic basis the Nore population (*M. durrovensis*) does not stand apart from the other Irish populations
2. Genetically the Irish populations fall into two groups (a) Nore/Derreen and (b) Blackwater/Owencarrew.

A final computation was made by construction of a Wagner tree (Fig. 12) based on the chord distances. The pattern of this tree is the same as that for the phenogram in Fig. 11 and confirms the close identity of the Irish populations.

Discussion

The results of the genetic analysis presented do not indicate that *M. durrovensis* is genetically distinct. Avise (1976) suggested that Nei's genetic identity (I) values of 0.900–1.000 were normally indicative of populations of the same species. The Irish populations have values of

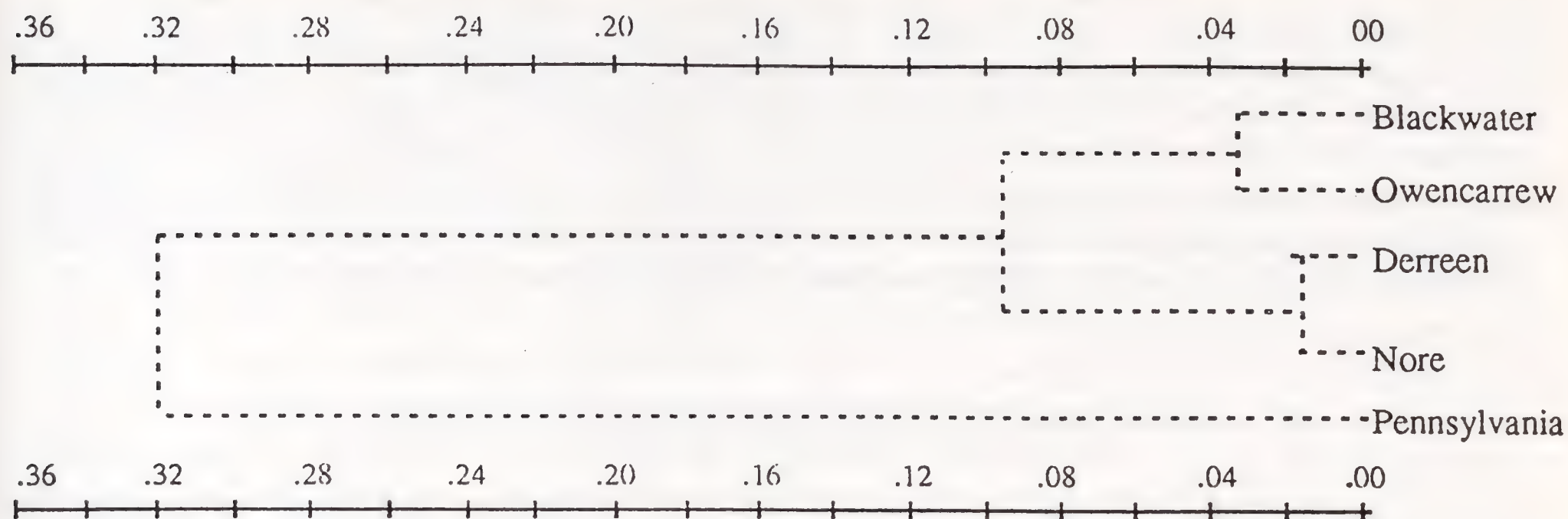


Fig. 11. Phenogram derived from genetic distances as calculated from the modified Rogers' method.

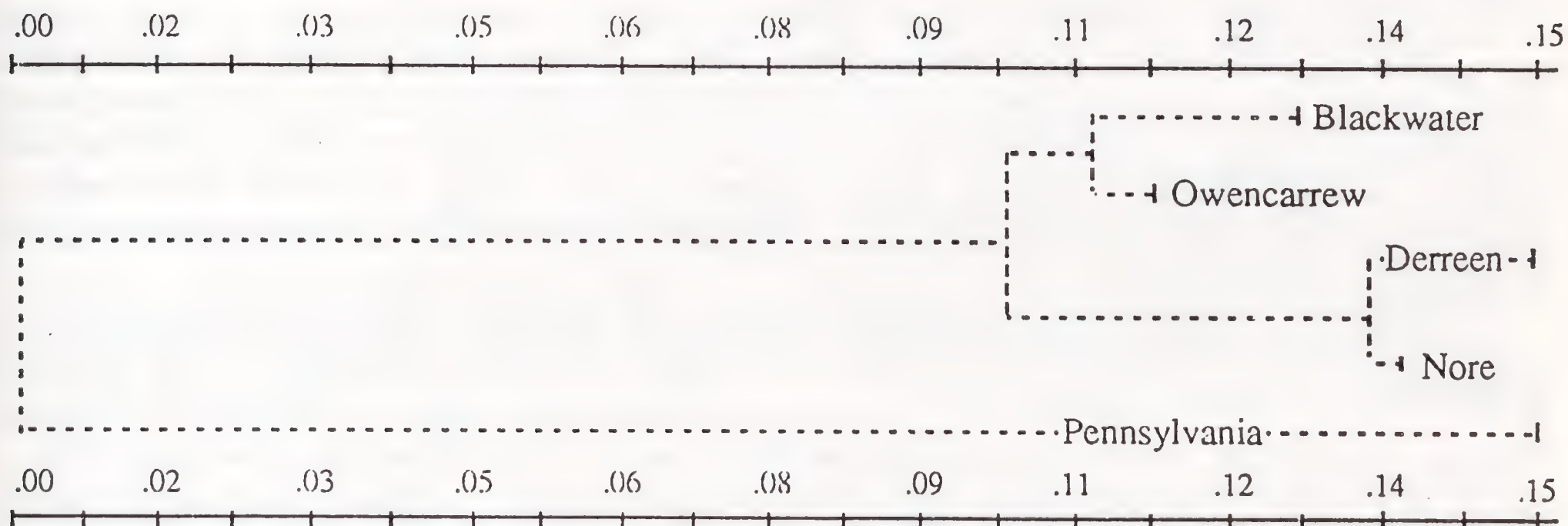


Fig. 12. A Wagner tree based on the chord distance and produced by rooting at the midpoint of the longest path.

0.987–1.000 indicating very great similarity. There is a distinct difference between the Irish and American populations. The value of the Rogers and Arc/Chord distances is that they are metric and do not compact taxa at the lowest end of the distance scale as does the Nei distance (reviewed in Davis *et al.* 1988). The distance of ≥ 0.29 is primarily due to fixation of alternative alleles at two loci. Given the vicariant and ancient separation of relevant populations the result is not unexpected. The difference is not so great that one would invoke subspecies status, especially as there are no significant morphological differences. Genetic differences between the Irish populations are slight and almost imperceptible between the Nore and the Derreen populations. Geographical proximity does not correlate with genetic identity as evidenced by the population from the Blackwater relating more closely to the northern Owencarrew population than to the geographically closer Nore or Derreen populations.

However, previous studies on North American Unionoidea, especially that of Davis & Fuller (1981), cast doubt upon the use of genetic identity alone to determine taxonomic status. They cite in particular cases where, morphologically distinct forms of *Elliptio* living sympatrically, had 98–99% genetic similarity. They went on to state that “If taxa with conchologically distinct phenotypes live sympatrically and in such numbers that they appear to be established populations, it is reasonable to consider them as species even though I values exceed 0.900”. *M. durrovensis* does not occur sympatrically in the sense that it is ‘not within striking distance’ of populations of *M. margaritifera* even if they exist within the

same river system, i.e. in the Suir tributaries and in parts of the Barrow or its tributaries, and we are forced to concur with Davis *et al.* (1981) that "Allopatric taxa with distinct shell phenotypes, but clearly of a phenotypically defined species group, with $I \geq 0.900$, present a problem at this time". They stated that careful examination of anatomy may resolve such problems. For *M. durrovensis* we are therefore required to consider all the factors at our disposal that will be reviewed in our final concluding remarks. For this section we can only reiterate that the results from genetic analysis indicate that all of the populations studied should be considered as belonging to a single species namely *M. margaritifera*.

SYSTEMATICS: CONCLUSIONS AND DISCUSSIONS

Taxonomic status of Margaritifera durrovensis

When we consider all the aspects that we have examined in assessing the taxonomic position of *M. durrovensis* do they point to an ecological or geographical population or to a definable species or subspecies? From the results of the analysis of morphology and genetics the status of *M. durrovensis* can be summarised as follows.

1. In shell characters, *M. durrovensis* has a thicker, heavier and uneroded shell but this represents one extreme of variation within a range of intermediates. It is noted that those populations living in intermediate hard water have shells of intermediate thickness and weight, but are however eroded. Other characters that were previously described as different, such as outline, muscle scar size, colour and hinge teeth, are shown in our analysis to be not at all significant.

Supporting evidence for the ecological control of shell form comes from the presence of shells typical of *M. margaritifera* in some of the non calcareous tributaries of the Barrow (Moorkens *pers. comm.*, historical collections – see Appendix 1) and the Suir (River Tar, this paper). Nowhere in the Nore-Suir-Barrow catchments do the forms occur sympatrically.

2. In relation to shell structure, the conchiolin layers were variable in structure between all populations examined but the single layer of *M. durrovensis* appears to be narrower than the others. However these layers have been found to vary in number in shells from different biotopes, with those inhabiting more acidic water having more layers. Given the variation between all populations we conclude that shell structure is also ecologically controlled.

3. In the anatomy we find that *M. durrovensis* does not significantly depart from *M. margaritifera*, particularly in features of the stomach, gill and mantle edge.

4. Genetic distances are so small that they suggest that all populations studied from both Ireland and N. America are part of a single species. Similar results were presented by Purser (1985) for British and German populations. Low genetic divergence has been noted between some species of *Elliptio* (Davis *et al.* 1981) and they gave three possible reasons:–

1. Lack of time due to a recent radiation
2. That the species were in fact phenotypes
3. That selection acts on the taxa to conserve alleles in the adults related to their functions within similar niches.

Kat & Davis (1984) were able to demonstrate conclusively the effect of time on genetic divergence and went on to state a generality that species of Margaritiferidae now occupying recently glaciated regions showed little divergence between populations at present. From the Pleistocene history of Ireland can any estimate be made of the time-scale for the production of an ecophenotype or genotype in populations of *M. margaritifera*? Colonisation of Irish rivers would have been affected by the migration of the fish hosts, thought to be trout or salmon, following the final retreat of the ice sheets. Salmon trout are the anadromous form of brown trout and Ferguson (*pers. comm.*) indicates that about 1% of the populations are thought to move around the coast between rivers. Geological data suggests that the ice

sheets finally receded from southern Ireland 14,000 years BP (G. F. Mitchell, *pers. comm.*). Records of fossil *M. margaritifera* shells in the British Isles are rare due to their dissolution in acidic conditions, but all are Post-glacial. An interglacial age for *M. durrovensis* shells from dredged river sands of the Nore, Suir and Barrow (McMillan & Zeissler 1990) must be regarded as doubtful due to the lack of supporting stratigraphical and dating evidence. To date, the oldest remains of freshwater fish yet found in Ireland are of salmon, trout and eel from a Mesolithic site, dated at c.8600 BP (Woodman 1985) and another Mesolithic site dated at 7500 BP (Brinkhuizen 1977). Assuming that the fish hosts migrated into southern Irish rivers immediately after the ice retreat we have a period of no more than 14,000 years for the isolation and divergence of the *durrovensis* form. In generation times, taken to be the average longevity, which is 40 years for *M. durrovensis*, this would be about 300. Generally this would be considered a very short time for the isolation and subsequent evolution of a unique genotype especially given the continuing introduction of new stock with the incoming migratory trout or salmon.

In the case of *Margaritifera* the phenotypic divergences are very small and the number of 'species recognised has always been small. If we examine the geological history of the family we find that the Margaritiferidae is the most ancient and anatomically conservative family of unionoidean mussels. It originated some 400 million years ago in the Devonian Period on the super-continent of Pangaea, and has undergone very little radiation during that time (Smith 1976). Davis *et al.* (1981) however assumed that the species of *Margaritifera* in their studies are of the same genus as those found as fossils, which dated from the upper Cretaceous Period, some 110 million years ago. Only seven or eight Recent species are currently recognised and only two of these are *Margaritifera sensu stricto* i.e. *M. margaritifera* and *M. falcata*. This history suggests that some factors have been acting on the family as a whole to prevent genetic divergence and these are likely to be related to life history strategy and the environmental conditions to which they have adapted.

The life history strategy of *M. margaritifera* with its high fecundity and long life span, coupled with the reliance on an encysting glochidial stage is indicative of a low population recruitment potential (Ross 1988). That recruitment is often precarious is reflected in the retained ability of *Margaritifera* to become self-fertile and this would also lead to low genetic divergence (Kat & Davis 1984). Both Bauer (1987), in W. Germany, and Ross & McCarthy (1991), in Ireland, indicate that *M. margaritifera* can produce hermaphrodites if populations are numerically small. This contrasts with a very large population in one river in Ireland in which less than one percent was hermaphrodite (Ross 1992). However the ability of this species to become hermaphroditic and self-fertile in unsuitable conditions or at low population densities indicates a method by which a small number of founder animals might establish a population in a suitable habitat, by the production of large numbers of glochidia, at the expense of the genetic variability and speed of evolutionary change that are conferred by sexual reproduction. If this has been a strategy adopted by the Margaritiferidae as a whole it could explain the limited radiation of the family.

One must also consider that *M. durrovensis* may be a relict species that once had a wider range in pre and interglacial times in lands to the south of modern Ireland. However this seems unlikely as there already existed a hard water species (*M. auricularia*) throughout France, the Iberian peninsula and extending into S E. England. It could be argued that in south-west Europe fast-flowing calcareous rivers are inhabited by *M. auricularia* and postglacial invasion of such rivers would have been by this species to the exclusion of *M. margaritifera*. *Margaritifera auricularia* was known to have reached the Thames but no further north or west in Britain (Preece *et al.* 1983, Preece 1988). Unfortunately little is known of the ecology of *M. auricularia* but its failure, and also that of the genus *Unio*, to reach Ireland may have created unfilled niches which *M. margaritifera* has been able to exploit. Such competitive exclusion among the Unionoidea has not been demonstrated in Europe and the

suggestion must remain purely speculative. The ability of the glochidial host species, namely trout, and perhaps salmon, in British waters, to survive in saltwater and in both hard and soft river waters indicates that introduction to all rivers was possible. Given that the glochidia can tolerate seawater (Purser 1985) it seems unlikely that they would be killed by calcareous water. There may however be a mechanism whereby the glochidia respond to low conductivity water as a key to a suitable environment for further development. Given the possibility of water chemistry changes in the Nore-Suir-Barrow system since Post-glacial times is it possible that the tolerance of *M. margaritifera* to hard water has been a process of gradual acclimatisation?

ECOLOGY

Distribution

Margaritifera durrovensis was first described from the River Nore at Attanagh Bridge, near Durrow and it appears that all subsequent records from the Nore were from the same locality. Our survey suggests that it is now restricted to a 20 km stretch of the main river from Shanahoe downstream to Inchbeg Bridge (Fig. 13).

Margaritifera durrovensis was also recorded from the rivers Suir and Barrow (Phillips 1928, Stelfox 1929) which gave rise to the generalisation that this form was distributed in the hard waters of the Nore-Suir-Barrow catchment which drains the southern sector of the central Irish plain. We were unable to find living material in the Suir catchment but dead shells were present in the main river. It appears that large areas of the Barrow are physically unsuitable for pearl mussels, although we were unable to survey any of the faster flowing tributaries or the upper reaches of the main river in the time available. Examination of material in museum collections (see Appendix 1) confirms that *M. durrovensis* was present in the Suir and Barrow. Ross (1991) records living *M. durrovensis* in the Suir at Clonmel in 1989, and also in the Barrow, but no further details are available. Lucey (1992) records it living at a number of sites in both the Suir and Barrow.

Despite this apparent general distribution our survey revealed specimens which show that typical *M. margaritifera* also occurs in the Suir and Barrow catchments. We found two eroded shells (*M. margaritifera*) in the Tar, a tributary of the Suir, near Clogheen. The Tar flows from the Galty Mountains which are composed of acidic Devonian and Silurian sandstones and conglomerates, from which it acquires its more acidic waters. This suggests that *M. durrovensis* occurs only in the calcareous water downstream in the main channel of the Suir, with typical *M. margaritifera* occurring in the more acidic tributaries. Similar to the find of *M. margaritifera* in the Tar, there are four specimens (in the NMI collections) from one locality on the Barrow, at St Mullins, Co Carlow, which differ in three being eroded (*M. margaritifera*) and the other uneroded (*M. durrovensis*). Moorkens (*pers. comm.*) has confirmed the presence of typical *M. margaritifera* in some non-calcareous tributaries of the Barrow.

Previously uncited specimens in the NMI collections (see Appendix 1), from the Liffey, Co Dublin and the King's River, Co Wicklow, do show resemblance to *M. durrovensis* as some have polished rather than eroded shells. However these rivers are acidic rather than calcareous, both originating in the granites of the Wicklow Mountains and should be investigated, although they may no longer contain any populations of freshwater pearl mussels.

Population size (Nore)

Unfortunately the information available in published records and with extant museum material gives scant indication of the original population sizes of *M. durrovensis* in these

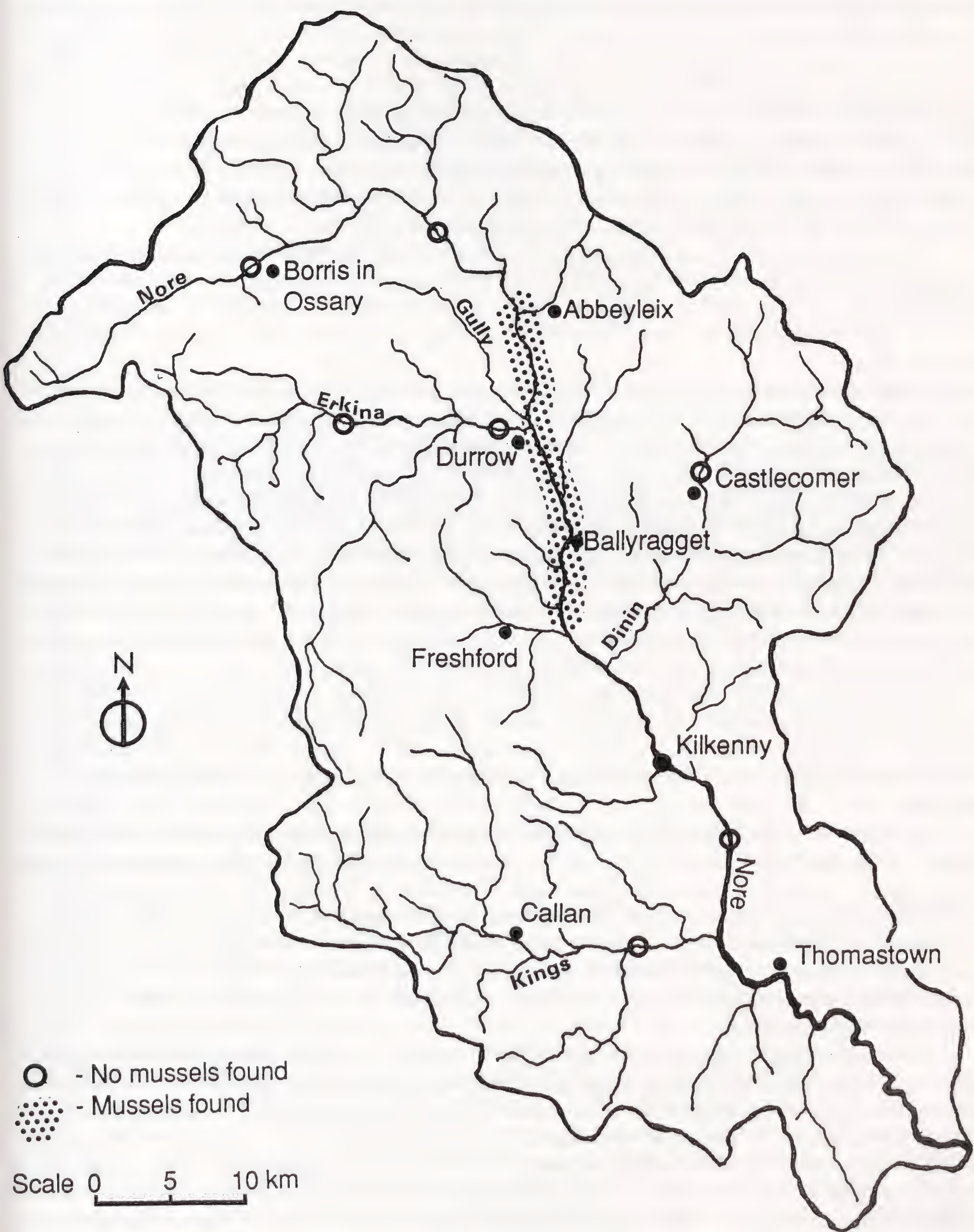


Fig. 13. Map of the River Nore showing the extent of the present population of *M. durrovensis*.

rivers. We have anecdotal information from local inhabitants that, in the Nore, until about thirty years ago, the mussels were plentiful and easily collected. It appears that considerable numbers of Nore shells were sent to Dublin, for 'mother of pearl' products. Although we searched the Nore extensively in the 1988–1989 field season for *M. durrovensis* we only found living mussels in a section of about 20 km. Mussels were often sparsely distributed singly or in small numbers and in only a few areas did they occur in groups of 50–100. On the basis of this we then estimated the population of *M. durrovensis* to be approximately 5000 (Ross 1990). Unfortunately, further field work in summer 1990 led us to revise this estimate down to approximately 2500. One site, which had contained 150 mussels in 1989, had been eradicated, by making an access for cattle drinking. In other areas, discharge from a milk factory was continuing and no living mussels were found downstream of the factory outlet. About 4 km. further downstream small numbers were sparsely distributed and none were found in the river beyond this point (Moorkens *et al.* 1990).

The population of *M. durrovensis* in the Nore would therefore appear to be seriously depleted and on the verge of extinction, and is thought now to number only about 2000 individuals.

Habitat (Nore)

The Nore, whose source is within a few kilometres of that of the Suir on the eastern slopes of the Devil's Bit Mountain, Co Tipperary, flows through Counties Laois and Kilkenny and traverses through peatlands from the upland acid drifts of the Old Red Sandstone on to the lower limestone gravels of the Irish midlands from which the water acquires its very high calcium content. The upper tributaries are mostly small and fast-flowing over a bed of coarse, sandy gravel and cobbles but on reaching the fertile limestone plains the main river acquires the characteristics of a typical calcareous lowland river. Below Shanahoe, it becomes much wider and extensive gravel banks have accumulated in places. Further downstream, slow-flowing large pools are interspersed with faster flowing stretches. The steep banks, except where protected by tree or shrub growth, are rather sandy and collapse easily, especially in places where cattle have unlimited access.

The habitants of *M. durrovensis* in the Nore are not entirely typical of those recorded for *M. margaritifera* as a whole. *M. durrovensis* can be found in deeper, slower flowing and softer sediment conditions than those usually associated with *M. margaritifera*. A summary of the range of habitats in the Nore, recorded during July, for the years 1988–1990 were as follows:—

(1) *In gravel banks*: This habitat consists of medium size gravels usually in shallow water (only c. 0.1 m in 1990) deposited close to the banks and shaded by overhanging trees. In this substrate the mussels dig in deeply and only the posterior $\frac{1}{4}$ of the mussel is exposed.

(2) *In sandy gravels between rocks*: These sites are in fast flowing, relatively shallow water (c. 0.1–0.75 m in 1990) with large stones or rocks usually covered with algae or river moss and embedded in sandy gravel. Mussels are shallowly embedded downstream of individual rocks. This is probably the typical habitat described by most previous authors for *M. margaritifera* as a whole.

(3) *Among cobbles or between rocks*: These sites usually are at the tail-end of pools in water ranging from c. 0.3–1.50 m. The mussels lie lodged among cobbles and rocks that have very little sand or gravel between them. Weed cover (*Cladophora* type algae) is extensive and flow rate is moderate at these sites in summer.

(4) *Deep water*: The river bed is sparsely covered with large stones and rocks, between them is a shallow layer of rather silty sandy gravel. Water depth is typically 1–3 m. The mussels are only slightly embedded, but often lie free on the surface. Flow rate is slow in summer. These sites are usually shaded by overhanging trees and vegetation which apparently prevents the growth of algae on the river bed.

It is our opinion that shading and/or fast-flowing stretches of water correlate with the occurrence of *M. durrovensis*. The most obvious feature is that these areas are free of weed cover during the summer months. Given that this animal is a suspension feeder and requires a good supply of oxygen, especially when stressed by brooding glochidia in the summer months, it is possible that heavy cover of *Cladophora* could seriously impair feeding and respiration.

Water chemistry

Almost invariably *M. margaritifera* is cited as a soft water species (Boycott 1936) but its occurrence in some hardwater rivers in SE Ireland and Wales is contradictory. The published data of the water chemistry typical of *Margaritifera* habitats is often vague and lacks detail especially of ranges in variation. However detailed sampling from, for example, the Nore at 25 stations over one year, showed that the pH ranged from 7.9–8.6 and the water conductivity ranged from 375–780 $\mu\text{S}/\text{cm}$.

The main aspects of the water chemistry of the eleven rivers in this study from which we have analysed *M. margaritifera* specimens are given in Table 13. This gives ranges for those parameters related to water hardness namely: pH 6.4–8.9; total hardness 6–308 mg CaCO_3/l .

Water conductivity levels of typical *M. margaritifera* rivers, where healthy populations flourish and reproduce, are usually under 75–80 $\mu\text{S}/\text{cm}$. Bauer (1979) produced data which suggested that typical *M. margaritifera* populations were extinct or becoming so in European rivers in which conductivity levels were normally in excess of 80 $\mu\text{S}/\text{cm}$. Purser (1985) also indicated that *M. margaritifera* avoided sites with high alkalinity levels in relation to their corresponding conductivity levels. Bauer (1979) considered high conductivity levels to be an indication of eutrophication but Lucey (*pers. comm.*) suggests that this is not always the case. The water conductivity values for the Nore, (375–545 $\mu\text{S}/\text{cm}$), (240–635 $\mu\text{S}/\text{cm}$) Barrow, (410–620 $\mu\text{S}/\text{cm}$), and to a lesser degree the Usk, (maximum 246 $\mu\text{S}/\text{cm}$), Blackwater, (maximum 300 $\mu\text{S}/\text{cm}$) and Wye, (maximum 375 $\mu\text{S}/\text{cm}$), do however reach what would be considered as excessively high levels of water conductivity for a healthy *M. margaritifera* river. The long term presence of the pearl mussel in habitats with these high conductivity levels suggests that the significance of conductivity values is more complex and requires further study.

High nitrate levels also reflect eutrophication which increases mortality rates of both post-parasitic juveniles and adult mussels. The Barrow, Nore and Suir, and also the Blackwater and the Derreen, all show nitrate levels substantially above 1.5 mg/l N, which probably accounts for the notable absence of young mussels in these populations (Bauer 1988).

Other than direct habitat destruction we recognise that eutrophication is the most likely cause of decline in mussel numbers. The overall biological water quality of Irish rivers is usually given by 'Q' values which give an index of pollution (Clabby *et al.* 1989).

The Nore values have been charted every four years from 1971–1987. In the main they indicate a deterioration of water quality during this time. In 1971, for example, of the 13 stations sampled, 9 had Q values of 5; 3 were graded at 4–5, showing slight pollution; 1 at 3–4. In 1987, one of these 13 sampling stations had retained a Q value of 5; 6 were regraded at 4; 1 was regraded at 4–5 showing some pollution and the remaining 5 were regraded at 3–4 showing more pollution. It would appear that by present standards the river is, and has for some time, been unsuitable for mussels downstream from Kilkenny (Clabby *et al.* 1989).

The water quality of the Suir is considerably worse than the Nore and has likewise deteriorated since 1971 with many stations graded at 2 or 2–3 (Flanagan & Larkin 1986).

Unfortunately, it is clear that the Barrow, especially in its middle region was in bad condition even in 1971, when it was graded, between Athy and Carlow, at 1 or 1–2, showing

Table 13. Water chemistry of rivers containing *M. margaritifera* and *M. durrovensis* in this study.

River	Conductivity μS/cm	pH	Total Hardness mg CaCO ₃ /l	Q-Value	BOD 5 mg/l	Total Ammonia mg/l	Chloride mg/l	Ortho- phosphate mg/l	Oxid. nitrogen/nitrate ppm
Owencarrew	—	6.8	—	4,4,5,5	—	—	—	—	—
Owenea	76	6.5–7.7	4–7 (Ca ppm)	5,4/5,3/4,5,4,4	1.04–1.09	>0.02	9–16	0.12	0.05–0.12
Barrow	240–635	7.8–8.3	—	3,1–2,4	1.7–3.9	0.045–0.15	11–24	0.020–0.140	0.069–2.40
Derreen	65–210	7.1–7.5	—	4,4–5,3–4,3,3	1.1–2.4	0.030–0.11	8–16	0.020–0.060	0.089–2.50
Nore	375–545	7.9–8.1	245–260	3/4,4,3/4,2/ 3,3/4	1.5–3.7	0.025–0.08	18–20	0.020–0.080	0.080–2.00
Suir	410–620	7.9–8.1	185–308	4,3/4,2/3,3/ 4,4	1.5–3.7	0.040–0.165	16–22	0.030–0.089	0.060–1.79
Blackwater	90–300	6.6–7.9	26–115	3,4	0.7–8.1	0.010–0.10	19–21	0.010–0.420	0.061–1.50
Spey	35–62	6.5–6.7	6–11	—	0.7–1.1	0.016–0.093	7–23	0.006–0.026	0.07–0.14
Kerry	55–75	6.6–7.4	8–19	—	0.5–0.6	0.006–0.016	14.7–27	>0.002	0.024–0.027
Usk	77–246	6.4–8.5	48–112	—	0.2–3.0	—	6.5–18.9	—	—
Wye	56–375	6.8–8.9	28–187	—	0.4–4.5	—	8.3–28.6	—	—

Table 14. Q-values and their relation to water quality and river condition

Q-value	Water quality	Condition of river
Q5	good	satisfactory
Q4	fair	satisfactory
Q3	doubtful	unsatisfactory
Q2	poor	unsatisfactory
Q1	bad	unsatisfactory

it then had seriously polluted water. By 1986, however, restrictions and closer control of effluent discharge led to improved water quality, at levels of 3–4 and 4.

It would appear therefore that, for possibly at least 30 years, water quality in these rivers has been deteriorating, often to seriously polluted levels, which would have been extremely harmful to the original populations of *M. durrovensis* and would have initiated the reduction of their population sizes. Although the authorities have taken steps to improve the water quality in recent years there may not be sufficient time to allow recolonisation of formerly suitable areas in the Nore, Barrow and Suir before the remaining populations become extinct.

CONSERVATION PROPOSALS

Margaritifera margaritifera is already a protected species in Ireland under the Berne Convention of the Council of Europe, to which the Irish Government is a signatory. Therefore, given the unique occurrence of the ecophenotype, *M. durrovensis* in the Nore-Suir-Barrow catchment, this latter form should be accorded special attention for the following reasons:–

1. The classification of *M. durrovensis* as an ecophenotype of *M. margaritifera* does not detract from its need to be conserved. It is a form unique to Ireland, where its habitat is the highly calcareous rivers which, in Germany, France and the Iberian peninsula, are inhabited by *M. auricularia*. *Margaritifera auricularia* is in fact the only margaritiferid which is usually cited as a hard water species. Evidence suggests that *M. auricularia*, though formerly widespread, is now practically extinct in its last remaining biotopes in Europe. Consequently *M. durrovensis* may represent the only living margaritiferid inhabiting hard waters in Europe.

2. It has been recognised that endemic species, subspecies or races are important for the conservation of biodiversity which is now considered to be the most important goal in terms of global conservation aims. Vane-Wright *et al.* (1991) contend that we should recognise that rare or endemic fauna and flora do not exist in isolation, but usually within well defined ecosystems, on which they are dependent, but to which they make their own unique contributions. This means that the whole biota of an ecosystem must be conserved in a pristine state, not just the individual taxa. Biodiversity encompasses not only genetic biodiversity but also the adaptive diversity of biota to different biotopes. This is an aspect which we require to investigate urgently for many animals in today’s fast-changing environments and to which resources and research must be directed with some urgency. The large freshwater mussels and in particular *Margaritifera*, with its regional variations, would therefore constitute valuable elements in the conservation of biodiversity of freshwater inhabitants in Ireland.

3. These endemic *M. durrovensis* populations are also scientifically valuable because

endemic faunas can provide the raw material needed to further our understanding of ecological adaptation and its part in the process of evolutionary change. As Burky (1983) points out, the acquisition of additional knowledge to further the understanding of the processes and mechanisms involved in evolution necessitates the study of the ecological and physiological adaptations which 'fit' animals for particular environments. This involves the acquisition of data from living populations on such aspects as life cycle, population dynamics, production efficiency, reproductive efficiency, and genetics in both time and extent for inter- and intra-specific comparisons.

4. The Nore is also unusual in that *M. margaritifera* and the freshwater crayfish (*Austropotamobius pallipes*) are found living together. Few other biotopes in Ireland or the rest of the British Isles are shared by both. These crayfish are also scheduled for conservation and habitat protection under the Berne Convention. Therefore the Nore biotope contains at least two animals which are required to be protected by government legislation. However, we understand that to date, the uniqueness of the hard water habitats of the Nore and its total flora and fauna assemblages have not been recognised. Therefore priority should be given to the evaluation of this whole ecosystem in terms of its total conservation potential.

We recognise that for any government to undertake conservation of key biota and biotopes then large resources will be needed. However, if priority is given to financing economic or industrial development then the resources available for nature conservation will always be minimal and of low priority. In the meantime, many habitats and their biota are being, and will continue to be, destroyed, often before any assessment has been carried out.

If a number of Mussel Reserves are projected by the Government for the conservation of *M. margaritifera* in Ireland then the Nore population should be encompassed in one of these Reserves. The large populations of *M. margaritifera* in Ireland may comprise one of the last strongholds of the species in Europe, given its extinction or terminal decline in most European countries (Ross 1990). It would be impossible to relocate the small remaining Nore population to another river as evidence from translocation studies in Finland (Valovirta 1990) shows that mortality would be in the region of 80% and movement is only recommended for large populations. Other European countries are actively pursuing measures to help conserve and increase their remaining populations of *M. margaritifera* through supplementing their recruitment by introducing artificially infected fish hosts. However, if the water is of insufficient quality to support healthy fish populations then it must also adversely affect the invertebrate fauna and probably to a greater extent.

Mussel Reserves

Should the Irish Government consider setting up freshwater reserves to conserve a variety of valuable freshwater habitats? Ideally, pearl mussels should not be the sole focus of such conservation proposals, even though much attention has been directed to them on a European basis through the Berne Convention. The main focus should be the conservation of the widest variety of freshwater biotopes in Ireland in order to encompass as much of the total biodiversity of flora and fauna in this island as possible. This would make them, not only more scientifically valuable, but also more financially viable.

However, other European countries, such as Germany, Czechoslovakia and Finland, alarmed at the depletion in their pearl mussel populations are already giving priority to conserving their remaining stocks by setting up reserves in which they are completely protected (Valovirta 1990). Ideally, they should encompass a representative range of biotopes in which *M. margaritifera* occurs in Ireland. Such a reserve on the River Nore would involve the purchase of a suitable length of river and would require a management programme supported by legislation. We suggest that the river course plus 30 m strips on each bank be protected for a minimum length of 5 km. The section of river encompassing the main population of mussels, which already has an amount of suitable tree and shading

cover, should be encompassed within the reserve. It would be essential that the water quality of the river upstream of the reserve be improved and maintained.

If the resources are not immediately available in the short term then the following measures should be implemented with some urgency.

1. The Nore mussel population should be designated with 'strictly protected species' status and a public awareness campaign should be undertaken. (Similar to the Bat Awareness Campaign).

2. A complete ban on any exploitation or disturbance other than for research purposes, should be enforced immediately.

3. Urgent measures should be directed towards improving and maintaining the water quality of the river inside and upstream of their present range. (All types of pollution input should be assessed and existing legislation should be rigorously enforced).

4. The stocks of brown trout under three years old should be increased to a suitable level and maintained.

5. The river banks should be protected by ensuring that land-owners are required to fence them off. Cattle have already caused large areas of the banks to collapse on to groups of mussels, destroying them.

6. The present water flow regime should be maintained and the river course and bed should be left unaltered. No drainage schemes or water extraction plants should be permitted.

7. Trees and other suitable shading vegetation should be preserved and increased.

Research

It is to be hoped that this review of *M. durrovensis* has highlighted the importance of this animal, not only in Ireland but in a wider European context. Funding should be made available, not just to conserve the *durrovensis* ecophenotype of *M. margaritifera*, but also to carry out research into all the aspects of its biology, ecology and life history strategy which have enabled it to colonise a habitat which is usually hostile to *M. margaritifera*. These would be mainly related to acquisition of information about its specific ecological requirements, the life cycle, including host-fish relationship, population dynamics, production and reproductive efficiency and life history strategy and would encompass both long and short term projects.

SUMMARY

1. Aspects of *M. durrovensis* which formed the basis of its separation from *M. margaritifera* were reviewed in comparison with specimens of *M. margaritifera* from other soft, intermediate and hard water rivers in Ireland, Scotland, Wales and N. America.

2. Anatomical analysis indicates that *M. durrovensis* does not differ significantly from *M. margaritifera*, particularly in features of the stomach, gills and mantle edge, which had previously been used to indicate specific distinction.

3. *M. durrovensis* has an uneroded, thicker and heavier shell than *M. margaritifera* specimens from other rivers, but this is at one extreme of the variation found in these characters between acidic and calcareous biotopes. However *M. margaritifera* shells from all other rivers, even from rather calcareous rivers, are decorticated to a greater or lesser extent.

4. The internal conchiolin layers in the shell, which occur in all margaritiferids, number only a single layer in *M. durrovensis*. This is also narrower than in specimens of *M. margaritifera* and we conclude that shell structure is ecologically controlled.

5. In the genetic analysis of *M. durrovensis* and three Irish and one N. American

populations of *M. margaritifera*, all showed very low allelic polymorphism and lack of genetic divergence. *M. durrovensis* did not stand apart genetically from the other Irish populations which all diverged slightly from the N. American population. However all are considered to be part of a single species.

6. On the basis of this evidence *M. durrovensis* is considered to be an ecophenotypic form of *M. margaritifera* which is insufficiently differentiated at this stage to be allocated subspecies status.

7. The unique colonisation of these hard water Irish rivers by the *durrovensis* form within the last 14,000 years provides a rare opportunity to study ecological and physiological adaptation, if the remaining population can be conserved.

8. It is recommended that resources should be allocated for the creation of a 'Mussel Reserve' as a means of conserving this mussel and its highly unusual habitat to enable further study and evaluation.

ACKNOWLEDGEMENTS

We would like to express our thanks to the following who have contributed support, assistance and advice to us. The Director and Trustees of the Ulster Museum, Belfast and The Wildlife and National Parks Service, Dublin provided funding for the project and the colour plates respectively. Discussions with Dr M. Young, Aberdeen University, Mr F. Woodward, Glasgow Museum, Dr M. Speight, Wildlife Service, Dublin, and Prof. A. Ferguson, Queen's University, Belfast, proved invaluable. Dr C. Fleming and colleagues, Queens University, Belfast, assisted with transport facilities for the specimens for genetic analysis. Dr J. O'Connor, National Museum of Ireland, Dublin, Dr P. Mordan, Natural History Museum, London and Dr B. Metivier, National Museum of Natural History, Paris, provided materials from their collections for analysis and illustration. The photographs were executed by Mr. K. Thomas, National Museum of Wales, Cardiff. The water chemistry analyses for Wales and Scotland were provided by the National River Authorities and for the Irish rivers by the Environmental Research Unit, Dublin. This is a contribution, in part, of the molecular genetics laboratory of the Department of Malacology of the Academy of Natural Sciences of Philadelphia. The study was funded in part by a NSF award to George M. Davis No. BSR-85002796. Caryl Hesterman aided in the electrophoretic analysis.

REFERENCES

- AVISE, J. C. 1976. Genetic differentiation during speciation. In *Molecular Evolution*. (Ed. Ayala, F. J.), 106–122. Sinauer Associates.
- BAUER, G. 1979. Untersuchungen Zur Fortpflanzungsbiologie der Flussperlmuschel (*Margaritifera margaritifera*) im Fichtelgebirge. *Arch. Hydrobiol.* **85**: 152–165.
- 1987. Reproductive strategy of the freshwater pearl mussel. *J. Anim. Ecol.* **56**: 691–704.
- 1988. Threats to the freshwater pearl mussel, *Margaritifera margaritifera*, in central Europe. *Biol. Cons.* **45**: 239–253.
- 1991. Plasticity in life history traits of the freshwater pearl mussel – Consequences for the danger of extinction and conservation measures. In *Species conservation – A population-biological approach*. (Eds. Seitz, A. & Loeschke, V.), Birkhauser Verlag.
- 1992. Variation in the life span and size of the freshwater pearl mussel. *J. Anim. Ecol.* **61**: 425–436.
- BLOOMER, H. H. 1927. *Margaritifera margaritifera* – notes on the variation of the British and Irish forms. *Proc. malac. Soc. Lond.* **17**: 208–216.
- 1928. *Margaritifera durrovensis*. Anatomical notes. *Proc. malac. Soc. Lond.* **18**: 74–76.
- 1932. Anatomical notes on *Margaritifera*, Schumacher. *J. Conch., Lond.* **19**: 260–263.

- BOYCOTT, A. E. 1927. Oecological notes. 7. *Margaritana margaritifera* in hard water. *Proc. malac. Soc. Lond.* **17**: 184.
- 1936. Habitats of freshwater Mollusca in Britain. *J. Anim. Ecol.* **5**: 116–186.
- BRINKHUIZEN, D. C. 1977. Appendix 1. *Proc. prehist. Soc.* **43**: 197.
- BURKY, A. J. 1983. Physiological ecology of freshwater bivalves. In *The Mollusca: Systematics, Evolution and Ecology*, (Eds. Fretter, V. & Peake, J. F.), 2A: 335–383. Academic Press.
- CLABBY, K. J., LUCEY, J. & MCCARRIGLE, M. L. 1989. *The biological survey of river quality (1987)*. Environmental Research Unit, Dublin.
- DAVIS, G. M. 1984. Genetic relationships among some North American Unionidae (Bivalvia): Sibling species, convergence and cladistic relationships. *Malacologia* **25**: 629–648.
- & FULLER, S. L. H. 1981. Genetic relationships among Recent Unionacea (Bivalvia) of North America. *Malacologia* **20**: 217–253.
- HEARD, W. H., FULLER, S. L. H. & HESTERMAN, C. 1981. Molecular genetics and speciation in *Elliptio* and its relationships to other taxa of North American Unionidae (Bivalvia). *Biol. J. Linn. Soc.* **15**: 131–150.
- FORBES, V. & LOPEZ, G. 1988. Species status of Northeastern American *Hydrobia* (Gastropoda: Prosobranchia): Ecology, morphology and molecular genetics. *Proc. Acad. nat. Sci. Philadelphia.* **140**: 191–246.
- FLANAGAN, P. J. & LARKIN, P. M. (eds) 1986. *Water quality in Ireland. The Current Position. Part Two: River Quality Data*. An Foras Forbatha, Dublin.
- HAAS, F. 1911. On *Unio*, *Margaritifera*, *Pseudanodonta* and their occurrence in the Thames valley. *Proc. malac. Soc. Lond.* **9**: 106–112.
- 1924. Anatomische Untersuchungen an europäischen Najaden. I. *Arch. Molluskenk.* **56**: 66–82.
- 1948. On *Margaritifera durrovensis* Phillips and its affinities. *J. Conch., Lond.* **23**: 6–8.
- HEARD, W. 1974. Anatomical systematics of freshwater mussels. *Malacol. Rev.* **7**: 41–42.
- KAT, P. W. 1983. Conchiolin layers among the Unionidae and Margaritiferidae (Bivalvia): Microsculptural characteristics and taxonomic implications. *Malacologia* **24**: 298–311.
- & DAVIS, G. M. 1984. Molecular genetics of peripheral populations of Nova Scotian Unionidae (Mollusca: Bivalvia). *Biol. J. Linn. Soc.* **22**: 157–185.
- LUCEY, J. 1993. The distribution of *Margaritifera margaritifera* (L.) in southern Irish rivers and streams. *J. Conch., Lond.* **34**: 301–310.
- McMILLAN, N. F. & ZEISSLER, H. 1990. Recent and fossil Mollusca of the rivers Barrow, Nore and Suir, South-east Ireland. *Bull. Ir. biogeog. Soc.* **13**: 189–199.
- MITCHELL, F. 1976. *The Irish landscape*, Collins, London.
- MOORKENS, E. A., COSTELLOE, M. & ROSS, H. C. G. 1990. A study of the freshwater pearl mussel *Margaritifera margaritifera* in S.E. Ireland. Forest and Wildlife Service, Ireland. (Circulation limited).
- NEI, M. 1972. Genetic distance between populations. *Am. Nat.* **106**: 283–292.
- ORTMANN, A. E. 1912. Notes upon the families and genera of naiades. *Ann. Carnegie Mus.* **8**: 222–365.
- 1913. Studies in Najades. *Nautilus* **27**: 88–91.
- PHILLIPS, R. A. 1928. On *Margaritifera durrovensis*, a new species of pearl mussel from Ireland. *Proc. malac. Soc. Lond.* **18**: 69–74.
- PREECE, R. C. 1988. A second British interglacial record of *Margaritifera auricularia*. *J. Conch., Lond.* **33**: 50–51.
- , BURLEIGH, R., KERNEY, M. P. & JARZEMBOWSKI, E. A. 1983. Radiocarbon age determinations of fossil *Margaritifera auricularia* (Spengler) from the River Thames in West London. *J. archaeol. Sci.* **10**: 249–257.
- PURSER, G. J. 1985. *Factors affecting the distribution of the freshwater pearl mussel, Margaritifera margaritifera* (L.), in Britain. Unpubl. Ph.D. Thesis, University of Aberdeen, Scotland.
- ROSS, E., & MCCARTHY, T. K. 1991. The biology and conservation of the freshwater pearl mussel (*Margaritifera margaritifera*) in Ireland. *Proceedings 1st Irish Environment Researchers' Colloquium, Sligo, 1991*.
- ROSS, H. C. G. 1988. *Aspects of the biology of the freshwater pearl mussel, Margaritifera margaritifera*, in N. W. Ireland, with special reference to life history strategy. Unpubl. M.Sc. Thesis. The Queen's University, Belfast, N. Ireland.
- 1990. The potential role of Irish populations in the conservation of the freshwater pearl mussel (*M. margaritifera*) in Europe. *Environmental Encounters* **10**: 55–58. Council of Europe.
- 1992. Aspects of the reproductive biology of the freshwater pearl mussel, *Margaritifera margaritifera* (L.), in Co Donegal, Ireland. *Proceedings Unitas Malacologia Conference*, Edinburgh. 1986, 287–296.
- SMITH, D. G. 1976. Notes on the biology of *Margaritifera margaritifera* (Lin.) in Central Massachusetts. *Am. midl Nat.* **96**: 252–256.
- 1977. The distribution of the Margaritiferidae: a review and a new synthesis. *Bull. Amer. Malac. Union*, (1976), 42.
- 1979. Marsupial anatomy of the demibranch of *Margaritifera margaritifera* (Lin.) in northeastern North America (Pelecypoda: Unionacea). *J. moll. Stud.* **45**: 39–44.
- 1980. Anatomical studies on *Margaritifera margaritifera* and *Cumberlandia monodonta* (Mollusca: Pelecypoda: Margaritiferidae). *Zool. J. Linn. Soc.* **69**: 257–270.
- 1986. The stomach anatomy of some eastern North American Margaritiferidae (Unionoida: Unionacea). *Am. Mal. Bull.* **4**: 13–19.
- STELFOX, A. W. 1929. Land and freshwater Mollusca. *Proc. R. Ir. Acad.* **39**: (B) 5–10.

- SWOFFERD, D. L. & SELANDER, R. 1981. BIOSYS -1 *A computer programme for the analysis of allelic variation in genetics*. University of Illinois, Urbana. 60 pp.
- TEVESC, M. J. & CARTER, J. C. 1980. Environmental relationships of shell form and structure of Unionacean bivalves. In *Skeletal growth of aquatic organisms*. (Eds, Rhoads, D. C. & Lutz, R. A.), 295–322. Plenum Press.
- VALOVIRTA, I. 1990. Conservation of *M. margaritifera* in Finland. *Environmental Encounters* **10**: 59–63.
- VANE-WRIGHT, R. I., HUMPHREYS, C. J. & WILLIAMS, P. H. 1991. What to protect? – Systematics and the agony of choice. *Biol. Cons.* **55**: 235–254.
- WRIGHT, S. 1978. *Evolution and the genetics of populations*. **4**. Univ. of Chicago Press.
- WOODMAN, P. C. 1985. Prehistoric settlement and environment. In *The Quaternary History of Ireland*. (Eds. Edwards, K. J. & Warren, W. P.), 251–278. Academic Press.

APPENDIX 1

Review of recent and historical records of *Margaritifera margaritifera* relevant to the distribution of *M. durrovensis*.

NMI – National Museum of Ireland, Dublin; BM(NH) – The Natural History Museum, London. All measurements in millimetres.

River Barrow

- Co Carlow, Borris (NMI – 52–1895) 1sp, 9.68×4.55 , heavily eroded:– not *durrovensis*.
- Co Carlow, Borris (NMI – 21/7–/5–) (pre 1909) 1 sp, eroded:– not *durrovensis*
- Co Carlow, St Mullins (NMI – 7.2.32) 2sps, both labelled ‘var. *durrovensis*’ 79.2×40.5 , polished umbos, shell rough and uneven with ‘race’:– *durrovensis*; 83.9×37.2 , eroded umbos, light shell, long and narrow:– not *durrovensis*.

River Suir

- Co Tipperary, Clonmel (NMI – 1.1929) 1sp, 82.1×39.2 , polished rather than eroded, rough ‘bubbly’ shell, deep muscle scars:– *durrovensis*.
- Co. Tipperary, near Clonmel (NMI – 21/2–/2–9) (pre 1886) 1sp, 82.5×40.2 :– *durrovensis*.
- Co Tipperary, near Clonmel (BM(NH)) 3 sps, lengths 99.7; 87.5; 82.6, dissolved rather than eroded:– *durrovensis*.
- The following records are from the 1988–1990 surveys carried out by two of the authors (HCGR, PGO).
- Co Tipperary, Killaloe, 6 miles w. of Clonmel, 2 valves:– *durrovensis*;
- Co Tipperary, Castle Grace House, 2 articulated shells:– *durrovensis*.
- Co Tipperary, Knocklofty, 5 shell fragments:– *durrovensis*.
- Co Tipperary, Dinmore, 2 valves, uneroded:– *durrovensis*
- Co Tipperary, River Tar (tributary of Suir) 2–3 miles below Clogheen, 1 shell c. 95.0, eroded:– not *durrovensis* and 1 shell c. 85.0, slightly eroded:– not *durrovensis*.

PLATE 2

1. *Margaritifera auricularia* (Lamarck, 1819) Agen, River Garonne, France, 106 mm.
2. *Margaritifera auricularia marocana* Pallary, 1918 Fez, Morocco, 77 mm. Syntype.
3. *Margaritifera margaritifera* form *durrovensis* Phillips, 1928 River Nore, Ireland, 90 mm.
4. *Margaritifera margaritifera* (Linnaeus, 1758) River Derreen, Ireland, 93 mm.
5. *Margaritifera margaritifera* (Linnaeus, 1758) River Usk, Wales, 98 mm.
6. *Margaritifera margaritifera* (Linnaeus, 1758) River Owenae, Ireland, 148 mm.
7. *Margaritifera brunneus* (Bonhomme, 1840) River Viaur, France, 85 mm. Syntype.
8. *Margaritifera margaritifera* (Linnaeus, 1758) River Kerry, Scotland, 100 mm.
9. *Margaritifera margaritifera* (Linnaeus, 1758) River Spey, Scotland, 102 mm.



1



2



3



4



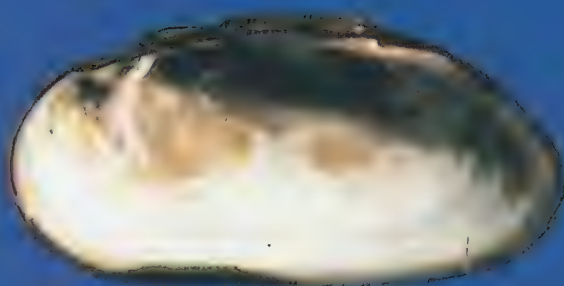
5



6



7



8



9

River Nore

Type locality – Co Laois, Attanagh Bridge, 1 mile S E Durrow – abundant in 1926 and 1952 – fide RAP and AWS.

All Nore shells and mussels from our survey and those in the Ulster Museum, NMI and BM(NH) collections are *M. durrovensis*.

Details of all Nore sites from the 1988–1990 survey are withheld from publication but are lodged with the Wildlife and National Parks Service, Dublin. It is sufficient to state that all shells and living mussels were found from Shanahoe to Inchbeg Bridge.

River Liffey

Co Dublin, Lucan (NMI – 84.1894) 1sp, 96.3×49.6 , heavy shell, polished umbos:– like *durrovensis*.

King's River

Co Wicklow, King's River (NMI – 03.1930) 2sps, 64.1×33.9 ; 83.1×41.6 , small, shallow, little eroded:– like *durrovensis*.

Co Wicklow, Blessington (NMI) 1 sp, 93.4×45.0 , little erosion:– not *durrovensis*.

Co Wicklow, Burgogne Bridge (NMI – 46.1931) 6sps, 57.2×23.2 ; 71.5×31.2 ; 65.2×30.5 ; 67.2×31.0 ; 67.8×32.2 ; 85.0×41.2 ; small, shallow very little erosion on several:– like *durrovensis*.

THE DISTRIBUTION OF *MARGARITIFERA* *MARGARITIFERA* (L.) IN SOUTHERN IRISH RIVERS AND STREAMS

J. LUCEY¹

(Accepted for publication, 17th October, 1992)

Abstract: The distribution of *Margaritifera margaritifera* in southern Irish rivers and streams is described using records collected since 1987. Some 1800 sites on almost 400 rivers and streams were examined of which 8.1 and 14.6% respectively yielded shells. The mapping method employed, based on 10-km squares, distinguishes between sites with living specimens and empty valves. Although it was recorded in a wide range of sites, some analyses of the site characteristics indicate the following fluvial habitat preferences: sites within a distance of 5–40 km from source; sites with a channel width of 11–30 m; sites with non-calcareous soils and strata (though not a strictly calcifuge species); sites on lowland terrain; unpolluted sites with a shaded aspect. It is concluded that although *M. margaritifera* is widespread in the region and that its true distribution was hitherto poorly recorded, a decline in some of its former sites is nonetheless apparent.

Key words: *Margaritifera margaritifera*, pearl mussel, Ireland, distribution, rivers.

INTRODUCTION

The freshwater pearl mussel occurring in Ireland has been recorded as *Mya margaritifera* (Turton 1816, Brown 1818), *Alasmodon margaritiferum* (Thompson 1843), *Alasmodon margaritiferus* (Thompson 1856), *Unio atratus* (Doyle 1854), *Unio margaritifera* (e.g. Humphreys 1845, Barker 1862–65), *Unio margaritifer* (e.g. Taylor & Roebuck 1886, Scharff 1892, Grierson 1903, Stelfox & Milne 1907), *Margaritana margaritana* (Taylor 1928) and *Margaritana margaritifera* (e.g. Stelfox 1911, Praeger 1950). All of these synonyms refer to one species, *Margaritifera margaritifera* (L.), despite the most distinct forms being described as separate species *viz.* *Margaritana pyrenaica* by Boettger (Stelfox 1911) and *Margaritifera durrovensis* by Phillips (1928). The latter populations from the River Nore were considered to be hardwater forms of the species by Haas (1948) as were apparently the specimens taken from the River Suir and called *Unio margaritifer* var. *sinuata* by Taylor & Roebuck (1886). In the Gaelic language various names have also been used to describe the mussel including *Closhen* (Smith 1750), *Fiarcan* (O'Hanlon & O'Leary 1907), *Breallacan* (Colgan 1914) *Sliogan neamainn* (Scharff 1916), *Sliogan neamhannach* (de Bhaldraithe 1959) and *Diuilicin fionnuisce* (An Roinn Oideachais 1978) though in the case of the second it is not clear whether *M. margaritifera* or *Anodonta cygnea/anatina* was intended.

The known occurrence of the pearl mussel was summarised by Redding (1693) in the late seventeenth century, by Thompson (1856) in the mid-nineteenth century and by Stelfox (1911), who employed the vice-comital divisions to plot the distribution, in the early part of this century. In the intervening periods some recordings, including chorologies, of its presence in various parts of the country have been published (e.g. Smith 1750, Radcliff 1814, Brown 1818, Humphreys 1845, Scharff 1892, Grierson 1903, Stelfox 1915, Taylor 1928). The

¹ Environmental Research Unit, Regional Water Laboratory, Butts Green, Kilkenny, Ireland.

most recent information for the country was included in the Conchological Society's *Atlas of the non-marine Mollusca of the British Isles*, as pre- and post- 1950 records, recorded on the basis of a 10 km grid (Kerney 1976). Data gathered, up to January 1990, for the updated edition of the *Atlas* show respectively 60 and 15 pre- and post-1950 10 km square records for Ireland (M. P. Kerney *pers. comm.*). For the part of the country covered in the present study, which is approximately one-third of the total area, the numbers of pre and post records are 29 and 3. Kerney (1975) noted during the preparation of the *Atlas* that for Ireland *M. margaritifera* could be confirmed living in only 13% (8 of 60) of previously recorded 10 km squares while Collins & Wells (1987) a decade later gave a figure of 19%.

It would appear from the foregoing that either a large decline in populations of *M. margaritifera* has occurred or alternatively that the species has been under-recorded in the past 40 years in Ireland. The prime objective of the present study is to establish its true distribution in the area covered. In addition the site characteristics of the rivers and streams will be examined in an effort to determine aspects of its habitat preferences.

METHODS

The part of the country covered in the surveys represents a total catchment area of approximately 28000 sq.km corresponding with the 14 Irish Hydrometric Areas numbered 11 to 24; for convenience the area in the study has been termed 'southern' but in a more strict sense it encompasses the south-east, south-west and south as well as a part of the mid-west and midlands. In this area 1812 locations on 398 rivers and streams were examined in the course of biological monitoring for water quality. On each river or stream the sample sites were typically located within a maximum distance of 5 km of each other. The sites examined on the rivers were limited to those accessible by wading and were therefore generally less than about 0.8 m in depth. All of the sites were at least cursorily, and in some cases intensively, searched for *M. margaritifera* shells.

The records, which date from 1987, have been plotted on the 10 km squares of the Ordnance Survey National Grid based on presence or absence. For recording purposes a distinction is made between presence of live specimens and empty valves although in the cases of the latter it does not necessarily mean that living mussels are not present in the 10 km square but simply that none were found in the areas searched.

The electrolytic conductivity data for the sites are expressed as $\mu\text{S}/\text{cm}$ at reference temperature of 25°C; approximately one-half of these are based on median values gleaned from Flanagan & Larkin (1992) and the remainder are spot measurements made by the author and, on his behalf, by Messrs J. Doheny and J. Ryan.

The classification of the sites for pollution status is the same as that used for reporting river quality nationally (Clabby *et al.* 1992), based on biological quality, and summarised as unpolluted (fair, fair/good and good quality), slightly polluted (doubtful/fair quality), moderately polluted (doubtful and doubtful/poor quality) and seriously polluted (poor, poor/bad and bad quality).

The river/stream site sizes were determined using a scheme based on distance from source in which five stages are recognised *viz.* streams (0–16 km), small rivers (16–40 km), medium rivers (40–80 km), large rivers (80–130 km) and very large rivers (>130 km). The channel width, as metres of substratum covered by water, has additionally been used as a measure of site size.

The following sources have been used for map compilations: solid geology (Freeman 1950, Geological Survey of Ireland 1962), rainfall (Rohan 1986), soil-type and physiography (Mitchell 1976, An Foras Taluntais 1980).

RESULTS

Of the rivers and streams surveyed 58 (14.6%) had either living individuals or evidence of *M. margaritifera* habitation in the form of empty valves. *Margaritifera* shells were found at 147 (8.1%) of the sites examined with confirmed live specimens at 124 (6.8%) and these are summarised within 10 km squares in Fig. 1.

The distributions of calcareous and non-calcareous strata and soils in the area covered in surveys are delineated in Fig. 2 together with land above/below 150 m and rainfall over/under 1000 mm. Comparing these with Fig. 1 it can be seen that the distribution of *M. margaritifera* corresponds broadly with areas of non-calcareous strata and soils as well as with areas above 150 m elevation and mean annual rainfall over 1000 mm.

In order to test the occurrence of *Margaritifera* more fully with the solid geology, soil-type and general physiography the sites were plotted using the geological map of Ireland (Geological Survey of Ireland 1962) and the soil map of Ireland (An Foras Taluntais 1980) as background. In the absence of adequate data on alkalinity and hardness, to reflect the

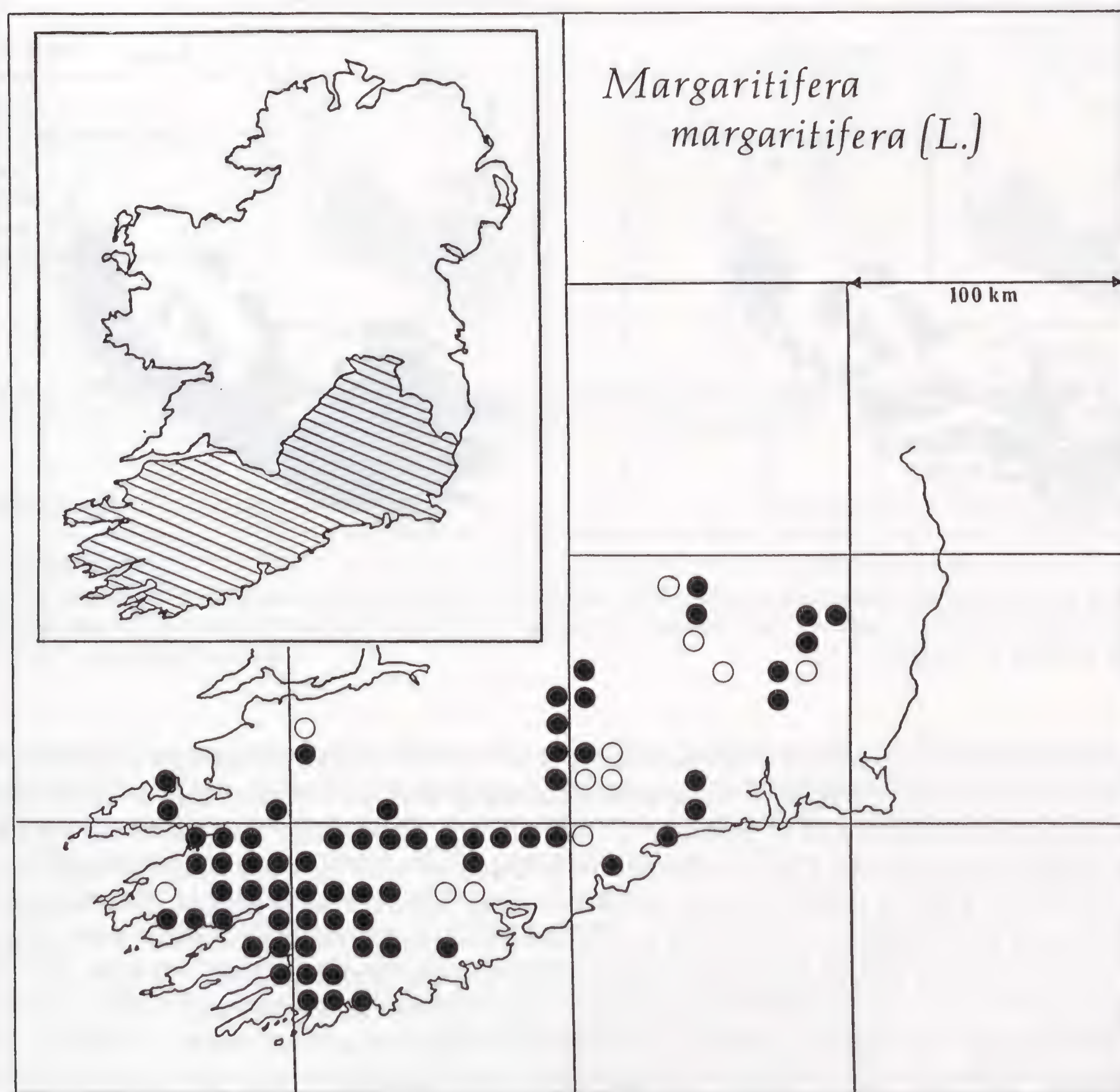


Fig. 1. The distribution of *Margaritifera margaritifera* in southern rivers and streams of Ireland from records collected since 1987 and based on 10 km squares. The solid black circles indicate living specimens while the open circles represent sites where 'shells only' were found. The study area is shown as hatched in the inset.

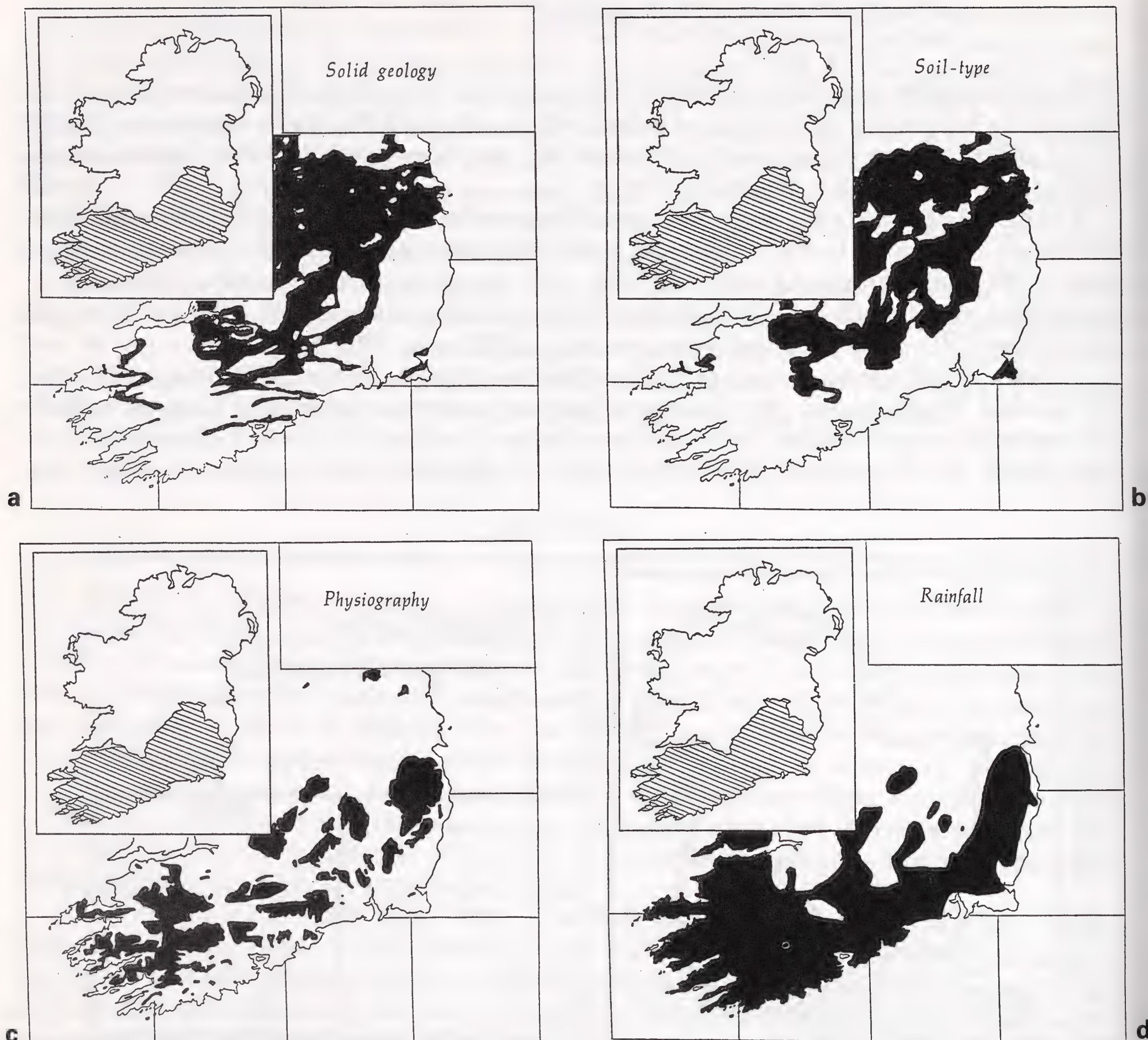


Fig. 2. The distribution of calcareous strata (top left), calcareous soils (top right), land above 150 metres (bottom left) and average annual rainfall over 1000 millimetres (bottom right) shown as darkened areas. The study area is shown as hatched in the insets.

natural chemical characteristics of the waters from which *Margaritifera* was recorded, the electrolytic conductivity has been used as a measure of the ionic concentration of the sites. The conductivity of a site will be influenced, *inter alia*, by the geology and soil of an area and is included in the analyses. The occurrence in relation to solid geology and conductivity of sites is shown in Table 1 from which it can be seen that just over 48% of occurrences were on Carboniferous strata almost one-half of which were Carboniferous Limestone. The greatest frequency occurrence was on Old Red Sandstone strata and it can be deduced from the table that just over 76 and almost 24% respectively were on non-calcareous and calcareous rock types. In a similar test regarding soil-type (Table 2) *Margaritifera* occurred most often at sites with brown podzolic soils. When the soil-types are classified into non-calcareous and calcareous we find that just over 88 and 11% respectively of sites occur on each. In the third analysis, shown in Table 3, in which the occurrence is compared with four broad physiographic divisions, as delineated on the soil map of Ireland (An Foras Taluntais 1980),

LUCEY: DISTRIBUTION OF *MARGARITIFERA MARGARITIFERA* IN IRELAND

Table 1. Percentage occurrence of *Margaritifera margaritifera* in relation to solid geology and conductivity of sites in southern Irish rivers and streams.

Solid Geology	Occurrence	Conductivity (μ S/cm)
Old Red Sandstone	38.1	40–354
Granite & Felsite	8.8	88–345
Rhyolite	2.0	113–136
Ordovician Grit & Slate	1.4	297–325
Silurian Grit & Slate	0.7	159
Pre-Cainozoic Basalt	0.7	161
Millstone Grit & Flagstone	12.9	90–268
Avonian Shale & Sandstone	11.6	83–229
Carboniferous Limestone	23.8	73–600

Table 2. Percentage occurrence of *Margaritifera margaritifera* in relation to soil-type and conductivity of sites in southern Irish rivers and streams.

Soil-type	Occurrence	Conductivity (μ S/cm)
Brown Podzolics	38.1	65–325
Acid Brown Earths	18.4	80–363
Peat	12.3	150–195
Gleys	10.2	90–465
Peaty Podzols	9.5	40–121
Grey Brown Podzolics	11.5	289–600

Table 3. Percentage occurrence of *Margaritifera margaritifera* in relation to physiography and conductivity of sites in southern Irish rivers and streams.

Physiography	Occurrence	Conductivity (μ S/cm)
Mountain & Hill	10.2	40–195
Hill	2.7	111–189
Rolling Lowland	69.4	65–363
Flat to Undulating Lowland	17.7	150–600

M. margaritifera occurred most frequently on rolling lowland (almost 70%) and least on hills (almost 3%). If the occurrences are separated into just two broader categories, mountain/hill and lowland, then the frequency of occurrence is 13 and 87% respectively.

The frequency occurrence of *M. margaritifera* in relation to various categories of the following site characteristics: distance from source, channel width, conductivity and pollution status, is given in Fig. 3. With regard to conductivity it was found in a wide range, 40–600 μ S/cm; one-half of the occurrences were from sites in the range 101–200 μ S/cm (almost 72% were less than 200 μ S/cm) while just less than 3% were in the range 501–600 μ S/cm. It did not occur in any seriously polluted site although a single specimen was found at one site which was classed as moderately polluted. As would be expected the vast majority of occurrences (93%) were from unpolluted sites. It was recorded at some sites ($\sim$ 6%) which were ascribed as slightly polluted but it is worth noting that most, if not all, of these would in many other countries be regarded as unpolluted. In order to protect the highly sensitive

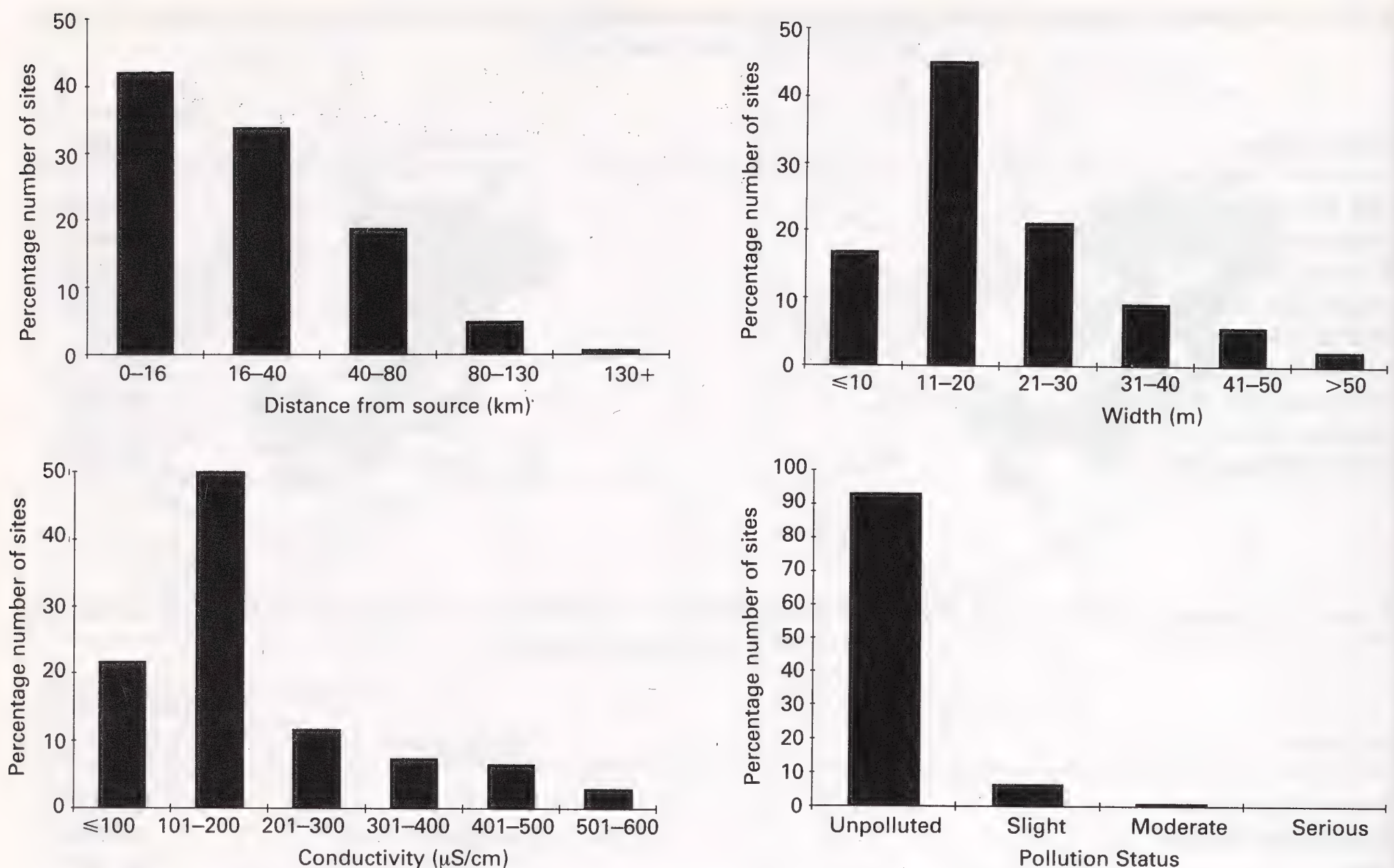


Fig. 3. Percentage occurrence of *Margaritifera margaritifera* sites in relation to distance from source, width, conductivity and pollution status in southern Irish rivers and streams.

ubiquitous salmonid fish occurring in Ireland a more stringent approach to assessing biological water quality is employed. *Margaritifera* occurred most frequently (42%) at sites in the distance range of 0–16 km from source i.e. in ‘streams’. Almost 76% of occurrences were found in this and the next category ‘small rivers’ i.e. 0–40 km from source. Just two site occurrences were less than 5 km from their source while only one was more than 130 km. It did not occur at any site with a channel width of less than five metres. It showed the greatest percentage occurrence (just over 45%) at sites between 11 and 20 m in width while the largest sites surveyed, greater than 50 m, showed the least (just over 2%). A total of 83% of the sites where *M. margaritifera* was found had a channel width of 30 m or less. The relationship between width and distance from source of the sites is shown in Fig. 4 and this indicates a statistically very highly significant correlation at 0.1% level of probability.

In the surveys *M. margaritifera* was found in all substrate types ranging from rocks and stones, through gravel and sand, to silt. These surveys were undertaken chiefly in the summer-autumn period (June–September) and the highest temperature measured at a site containing *Margaritifera* was 23°C.

Two other members of the Unionacea, *Anodonta anatina* and *A. cygnea* occur in some of the rivers covered in the present study. At one site *M. margaritifera* and *A. cygnea* were found in very close association, in the same substratum of silt/sand less than 2 m apart, where the median conductivity value was 300 μS/cm. In a site on another river, with a conductivity reading of 256 μS/cm, shells of *A. anatina* and *M. margaritifera* were found. In Britain these two species also occur together in the River Wye (Ellis 1978). In a study of Bavarian streams, in which three species of Unionacea live, Bauer *et al.* (1991) found that although *M. margaritifera*, in a few instances, was associated with *Unio crassus*, it never occurred with *A. piscinalis* (syn. *A. anatina*), whereas the two latter species frequently lived together in one river. Haas (1948) knew of only one locality where *M. margaritifera* and *A. anatina* were

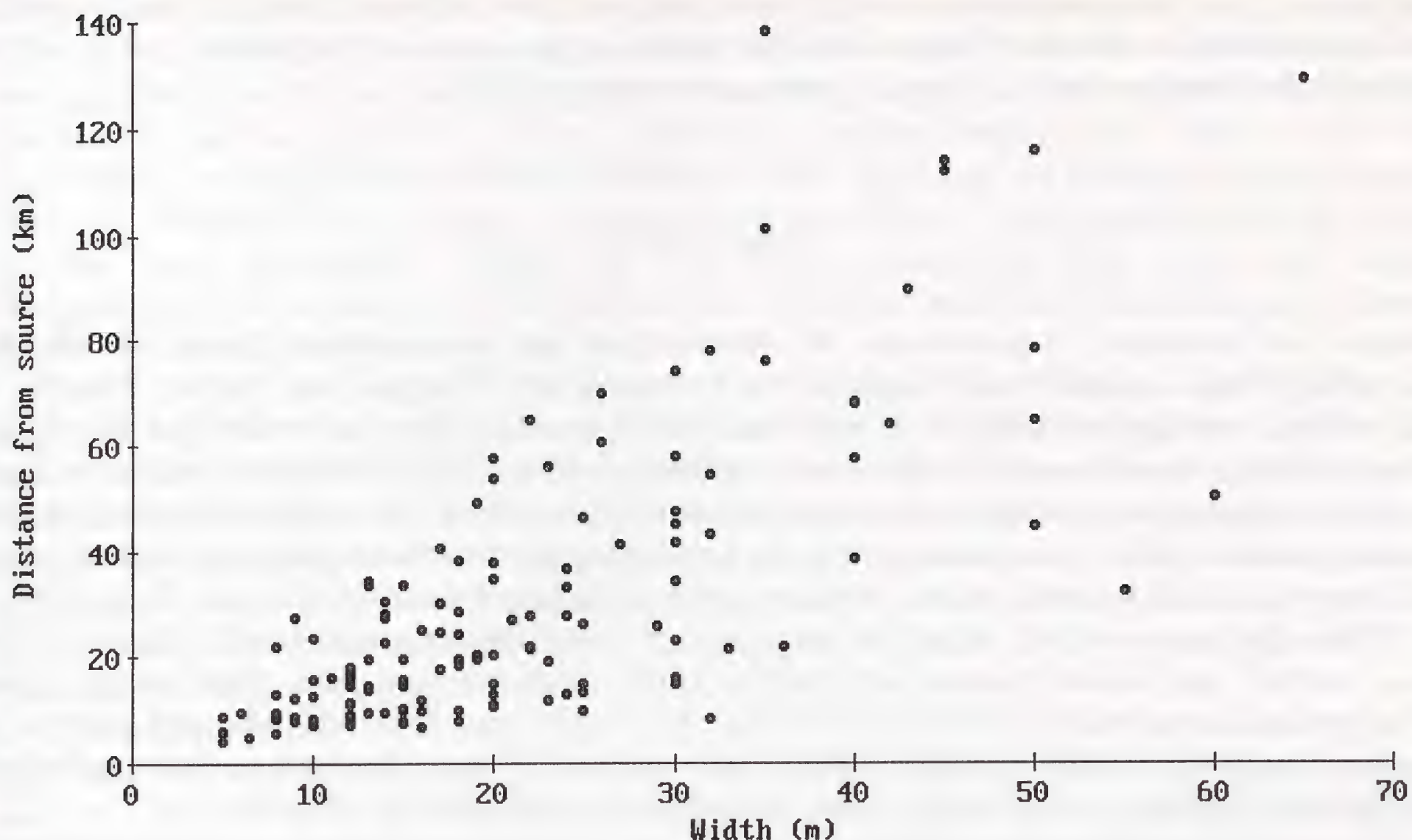


Fig. 4. Relationship between width and distance from source of *Margaritifera margaritifera* sites in southern Irish rivers and streams. $r = 0.74$, $P < 0.001$.

associated. The present study appears to be the first time that *M. margaritifera* and *A. cygnea* have been recorded together.

At 13 (8.8%) of the sites in 7 (12.1%) of the rivers where *M. margaritifera* was found in the present study, the crayfish *Austropotamobius pallipes*, which is classed as a calcicole species, also occurred.

The larval glochidial stage of *M. margaritifera* is parasitic on fish, primarily on the gills of Salmonidae (Bjork 1962, Bauer *et al.* 1991) which are ubiquitous in Irish rivers. During the surveys, fish were encountered at the *Margaritifera* sites with the following frequency: trout or salmon parr (Salmonidae) 70%, minnow (*Phoxinus phoxinus*) 50%, stoneloach (*Noemachilus barbatulus*) 16%, eel (*Anguilla anguilla*) 13%, stickleback (*Gasterosteus aculeatus*) 6%, gudgeon (*Gobio gobio*) 5% and perch (*Perca fluviatilis*) 1%. Although lamprey (Petromyzonidae) and flounder (*Platichthys flesus*) were occasionally recorded, these are excluded in this general analysis, which is only intended as a broad measure of association, as fish sampling was beyond the scope of the surveys. Except for those species which could have arrived from the sea, the bulk of the Irish freshwater fish fauna is thought to have been introduced by man and in the case of the minnow this may have been as late as the first quarter of the last century. Thompson (1856) was informed by a correspondent, in 1849, that there were no minnows in the southern rivers and that he had recently put some in two streams in Cork. If this was indeed the first introduction of the fish to southern rivers then it has achieved a remarkable dispersal throughout the region since that time. While minnows may become infected with glochidia (e.g. Jackson 1925) there is no evidence that they act as natural hosts for Irish *Margaritifera* populations and as far as is presently known only Salmonidae are suitable hosts.

Juvenile *M. margaritifera* were rarely encountered during the surveys. The smallest specimens, measuring ~20–30 mm in length, were taken in a gravel substratum sample of the upper reaches of the River Lee. A few in the length range 55–70 mm were seen but in the main those found were much larger and the largest specimen recorded was 148 mm.

Specimens have been seen at one site – some lying on their sides – spread across the width and one released a cloud of sperm into the water, as the valves were pressed, while being picked from the river bed (1 August; river temperature 18.9°C).

DISCUSSION

Despite its ecological requirements *M. margaritifera* has an extensive range worldwide, spreading from Iceland and Lapland to Portugal and Russia, and across Siberia to Kamchatka and Japan, while in North America it reaches from Labrador and Newfoundland to Pennsylvania and from Alaska to California (Ellis 1978). In Britain it is absent from the Midlands and south-eastern England, while in Ireland it is also absent from the Central Plain (Jackson 1925). It is considered to be a declining species throughout its natural range in Europe and has become extinct in some areas including Poland (Collins & Wells 1987).

From the present study it can be seen that *M. margaritifera* is widely distributed in the area covered and shows greatest expression in the south-western part. With regard to its vice-comital occurrence, 11 of the divisions (H1*–H7* and H11*–H14*) and parts of a further five (H8*, H10* and H18–H20) fall within the area covered in the study and *Margaritifera* shells were recorded from 13 of these as indicated by asterisks.

A peculiarity of *M. margaritifera* in its worldwide distribution is its almost total restriction to soft waters (e.g. Jackson 1925, Boycott 1936, Ellis 1978), although in Ireland it has been known from two hardwater rivers for some time (Taylor & Roebuck 1886, Phillips 1928). The available data on alkalinity and hardness of the water at the sites in the present study were insufficient to allow a meaningful assessment of the occurrence of *Margaritifera* in regard to these parameters. This will be addressed (Lucey, *in prep.*) when adequate measurements, being collected at present, have been gathered. The indications from the present study, particularly the conductivity results, would *prima facie* suggest that quite a number of sites, as many as 15%, would fall within the range of what could be described as slightly hard to hard waters.

Hendelberg (1960) pointed to the close agreement between the distribution of *M. margaritifera* and areas with soils and rocks poor in lime in southern Sweden. In the present study 88 and 76% of occurrences respectively were from sites with non-calcareous soils and rocks. Looking at the conductivity values associated with the different solid geology and soil-type in Tables 1 and 2, it would appear that the latter is a better indicator of, and has a greater influence on, the ionic concentration of the fluvial sites. Boycott (1936) was of the opinion that the hardness of waters could be guessed a good deal more accurately from a geological map than the calcareousness of the surface soil, since the water represents the deeper substance of the land rather than the superficial layers. However, most of the rivers in Ireland are cut in drifts, and have not as yet reached the underlying rock floor (Freeman 1950). In parts of the south the soils were drastically transformed by the effects of recent Quaternary glaciation. Charlesworth (1963) gives as an example the limestone valley of the River Blackwater, in County Cork, which is so laden with non-calcareous glacial drift from the Old Red Sandstone ridges, that scarcely one of the lime-loving plants of the Carboniferous Limestone is to be found within it. In the 140 km length of this river surveyed in the present study *Margaritifera* shells were found at 20 sites where the median conductivity ranged between 163 and 300 $\mu\text{S}/\text{cm}$.

M. margaritifera occurs at a very large range in altitude worldwide, rising from very little above sea-level to a height of almost 2300 m (Jackson 1925). In Arctic Sweden, Hendelberg (1960) found an upper limit of about 360 m, which was attributed to climatic conditions. Within the region covered in the present study it was not found at any site with an elevation

above about 150 m. Comparing the areas above 150 m, as delineated in Fig. 2, with Fig. 1 there is an apparent close correspondence between these and the distribution of *M. margaritifera*. However when the distribution was tested in relation to terrain (Table 3), it was found that this was decidedly lowland, particularly rolling lowland. In a letter written more than 300 years ago, October 1688, Redding (1693) described its habitat, in the places he knew *viz.* Donegal, Kerry, Louth, Tyrone and Waterford, as "All these places are at the feet of very great mountains". While the size of the mountains may have been slightly exaggerated, by this early observer, the site description is not wholly inaccurate as evidenced by the results of the present study.

Stelfox (1911) and Praeger (1950) give the habitat as the larger rivers in the mountainous marginal regions of Ireland. Boycott (1936) includes *M. margaritifera* among the Mollusca which show a great preference for and are almost restricted to what may be called large loci such as 'good sized rivers'. In the case of the large mussels, he says, the explanation may be that the fish on which they are dependent need roomy places. In the work presented here the occurrence of the species was tested using two measures of site size *viz.* distance from source and channel width, and the results show that the great majority of sites were respectively less than 40 km from source and 30 m or less in width.

Although Jackson (1925) reports that *M. margaritifera* seems to be "very susceptible" to light and emerges more out of the substratum in bright sunlight, it has during the present surveys, except in highly coloured rivers, most often been seen to occupy shaded sites particularly under trees. Light may act as an important indirect factor through, for example, stimulation of filamentous algal growth which in large amounts is inimical to *Margaritifera*. In the experience of Phillips (1928), and according to him that of other investigators, *M. margaritifera* inhabits open stretches of river exposed to full sunlight. The observations made during the present surveys would therefore appear to be at variance with those of earlier workers.

The results of the assessment of the fluvial habitat preferences of *M. margaritifera* in southern rivers and streams of Ireland may be summarised as follows: it occurs in a wide range of river sites but with greatest frequency in what have been categorised as streams and small rivers i.e. sites within a distance of 5–40 km from their source; it occurs most often at sites with a channel width of 11–30 m; it occurs predominantly at sites with non-calcareous strata and soils but is not strictly calcifuge; its occurrence in relation to conductivity values suggests that as many as one in ten of its recorded sites are slightly hard to hard waters; its typical site is chiefly lowland particularly rolling lowland; its typical locus is an unpolluted one with a shaded aspect.

The present work greatly extends the known occurrence of the species in the region surveyed and reflects, for the first time, the true picture of its distribution there. This study increases the 10 km square post 1950 records (to January 1990) of the Conchological Society, for *Margaritifera margaritifera* in the area covered, from 3 (Kerney 1976, M. P. Kerney *pers. comm.*) to 67 with 'shells only' recorded in a further 12. Of these 48 are new records. With regard to the pre-1950 square records, this study confirms living occurrences in 76%. The conclusion drawn from the present study is that while the species is widespread in southern Irish rivers and streams and has undoubtedly been under-recorded there in the past 40 years, it has nonetheless apparently declined in some of its former known sites.

REFERENCES

- BARKER, J. 1862–65. Notes on some dissections of the fresh-water mussel (*Unio margaritifera*). *Proc. nat. Hist. Soc. Dub.* **4**: 111–114.
- BAUER, G., HOCHWALD, S. & SILKENAT, W. 1991. Spatial distribution of freshwater mussels: the role of host fish and metabolic rate. *Freshwat. Biol.* **26**:377–386.
- BHALDRAITHE, T. DE, 1959. *English-Irish Dictionary*. Oifig an tSolathair, Baile Atha Cliath.
- BJORK, S. 1962. Investigations on *Margaritifera margaritifera* and *Unio crassus*. *Acta Limnol.* **4**: 1–109.
- BOYCOTT, A. E. 1936. The habitats of fresh-water Mollusca in Britain. *J. Anim. Ecol.* **5**: 116–186.
- BROWN, T. 1818. Account of the Irish Testacea. *Mem. Wernerian nat. Hist. Soc.* **2**: 501–536.
- CHARLESWORTH, J. K. 1963. *Historical Geology of Ireland*. Oliver & Boyd, Edinburgh & London.
- CLABBY, K. J., LUCEY, J., MCGARRIGLE, M. L., BOWMAN, J. J., FLANAGAN, P. J. & TONER, P. F. 1992. *Water Quality in Ireland 1987–1990. Part One: General Assessment*. Environmental Research Unit, Dublin.
- COLGAN, N. 1914. Field notes on the folk-lore of Irish plants and animals. *Ir. Nat.* **23**: 53–64.
- COLLINS, N. M. & WELLS, S. M. 1987. *Invertebrates in need of special protection in Europe*. Council of Europe Nature and Environment Series No. 35, Strasbourg.
- DOYLE, J. B. 1854. *Tours in Ulster*. Hodges & Smith, Dublin.
- ELLIS, A. E. 1978. *British Freshwater Bivalve Mollusca*. Synopses of the British fauna No. 11 (New Series). Academic Press for the Linnean Society, London.
- FLANAGAN, P. J. & LARKIN, P. M. (eds.) 1992. *Water Quality in Ireland 1987–1990. Part Two: River Quality Data*. Environmental Research Unit, Dublin.
- FORAS TALUNTAIS, AN, 1980. *Ireland – General Soil Map*. An Foras Taluntais, Dublin.
- FREEMAN, T. W. 1950. *Ireland, its Physical, Historical, Social and Economic Geography*. Methuen, London.
- GEOLOGICAL SURVEY OF IRELAND, 1962. *Geological Map of Ireland*. Ordnance Survey, Dublin.
- GRIERSON, P. H. 1903. Notes on the Mollusca of County Kilkenny. *Ir. Nat.* **12**: 307–311.
- HAAS, F. 1948. On *Margaritifera durrovensis* Phillips and its affinities. *J. Conch., Lond.* **23**: 6–8.
- HENDELBERG, J. 1960. The fresh-water pearl mussel, *Margaritifera margaritifera* (L.). *Rep. Inst. Freshwat. Res. Drottningholm.* **41**: 149–171.
- HUMPHREYS, J. D. 1845. The Mollusca, Crustacea and Echinodermata. In: *Contributions towards a fauna and flora of the county of Cork* (Eds. W. H. Harvey, J. D. Humphreys and T. Power). Cuvierian Society, Cork.
- JACKSON, J. W. 1925. The distribution of *Margaritana margaritifera* in the British Isles. *J. Conch., Lond.* **17**: 195–211.
- KERNEY, M. P. 1975. European distribution maps of *Pomatias elegans* (Müller), *Discus ruders* (Férussac), *Eobania vermiculata* (Müller) and *Margaritifera margaritifera* (Linné). *Arch. Molluskenk.* **106**: 243–249.
- (ed.) 1976. *Atlas of the non-marine Mollusca of the British Isles*. Institute of Terrestrial Ecology, Cambridge.
- LUCEY, J. in preparation. *Margaritifera margaritifera* (L.) in hard water in Ireland.
- MITCHELL, F. 1976. *The Irish Landscape*. Collins, London.
- O'HANLON, J. & O'LEARY, E. 1907. *History of the Queens County*. Vol. 1. Sealy, Bryers & Walker, Dublin.
- OIDEACHAIS, AN ROINN, 1978. *Ainmneacha Plandai agus Ainmhithe*. Oifig an tSolathair, Baile Atha Cliath.
- PHILLIPS, R. A. 1928. On *Margaritifera durrovensis*, a new species of pearl mussel from Ireland. *Proc. malac. Soc. Lond.* **18**:69–74.
- PRAEGER, R. L. 1950. *Natural History of Ireland*. Collins, London.
- RADCLIFF, R. 1814. Union of Enniscorthy (No. 15) In: *A Statistical Account or Parochial Survey of Ireland* (Ed. W. S. Mason). Vol. 1. Graisberry & Faulkner. Dublin.
- REDDING, R. 1693. A letter concerning pearl fishing in the north of Ireland (1688), communicated by Dr. Lister. *Phil. Trans. R. Soc. Lond.* **18**:659–664.
- ROHAN, P. K. 1986. *The Climate of Ireland*. Stationery Office, Dublin.
- SCHARFF, R. F. 1892. The Irish land and freshwater Mollusca. *Ir. Nat.* **1**: 177–181.
- 1916. On the Irish names of invertebrate animals. *Ir. Nat.* **25**:140–152.
- SMITH, C. 1750. *The Antient and Present State of the County and City of Cork*. Vol. 1 and 2. J. Exshaw, Dublin.
- STELFOX, A. W. 1911. A list of the land and freshwater mollusks of Ireland. *Proc. R. Ir. Acad.* **29B**: 65–165.
- 1915. A list of the land and freshwater Mollusca of the Dingle promontory. *Ir. Nat.* **24**:17–37.
- & MILNE, J. N. 1907. Further notes on the land and freshwater mollusca of Cork West and Kerry. *Ir. Nat.* **16**:286–289.
- TAYLOR, J. W. 1928. *Margaritana margaritana* in County Clare. *Ir. Nat. J.* **2**: 36.
- & ROEBUCK, W. D. 1886. Authenticated material towards a land and freshwater molluscan fauna of Ireland. *Proc. R. Ir. Acad.* **6**:672–692.
- THOMPSON, W. 1843. Report of the fauna of Ireland, Div. Invertebrata. *Report Brit. Assoc.* 245–291.
- 1856. *The Natural History of Ireland*. Vol. 4. Bohn, London.
- TURTON, W. 1816. Irish Conchology. *Dub. Exam. July*: 230–236.

TAXONOMY, ECOLOGY AND DISTRIBUTION OF *LEIOSTYLA* IN W. EUROPE AND NW. AFRICA (GASTROPODA: PUPILLIDAE)¹

M. B. SEDDON², D. T. HOLYOAK³ & P. TATTERSFIELD⁴

(Accepted for publication, 16th January, 1993)

Abstract: The status of *Leiostylula* in the Iberian peninsula and NW. Africa is reviewed. Examination of material of *Leiostylula anglica* from Britain and Ireland showed that shell characters such as size, shape, colour and development of apertural teeth were variable within and between populations. Shells of *Leiostylula numidica* from Algeria were also found to be variable. As the main distinguishing characters are shape of the shell and the absence of a basal plica and as both characters are variable, it is difficult to justify the separation of *Leiostylula numidica*. Factors influencing the range of *Leiostylula* in NW. Europe are discussed.

Key words: *Leiostylula anglica*, *Leiostylula numidica*, shell variability, range, biogeography.

INTRODUCTION

The genus *Leiostylula* is distributed through the Western Palaearctic with two principal centres of species diversity at opposite ends of this range on the Atlantic Islands (especially Madeira) and in the Caucasus. *Leiostylula anglica* (Wood, 1828) has the most northern distribution of the genus being widespread in Britain and Ireland. There are also records (based mainly on shells) from Portugal (Nobre 1941) and N. Spain (Prov. Galicia–Rolan & Otero-Schmitt 1988 Pokryszko & Waldén 1992; Provs. Cadiz, Grenada – Seddon & Tattersfield 1992) giving a range that could be described as Lusitanian, with occasional records from the regions between (Channel Islands and Ile de Ré; Fig. 1).

Many of the pupillid taxa described from NW. Africa are only known from a few specimens in museum collections. The identity of the species of *Leiostylula* reported from Algeria has been the subject of debate. Morelet (1853) provides the earliest record of *Leiostylula* in northern Algeria identifying the specimens as *Pupa anglica*. The record was subsequently confirmed by Bourguignat (1864) who believed that these shells differed from *Pupa anglica* and described a new species *Vertigo numidica* on the basis of shell characters such as the absence of a basal tooth. Gittenberger & Pieper (1988) examined the museum material of *Leiostylula numidica* as part of a description of a new species from Iran and followed Bourguignat (1864) separating these two species on the basis of shell characters. The other shell characters that have been used to segregate *Leiostylula numidica* are shell colour (mid-banded form) and smaller size.

The presence of species of the genus *Leiostylula* in NW. Africa was discussed by Gittenberger & Pieper (1988), Hausdorf (1990) and Manganeli, Giusti & Della Cave (1990). Gittenberger & Pieper (1988) provided an illustration of *Leiostylula numidica* from Algeria.

¹ Systematics and Biogeography of the Land Mollusca of NW. Africa. Contribution no 7

² Dept of Zoology, National Museum of Wales, Cathays Park, Cardiff, CF1 3NP, U.K.

³ Present Address c/o 22 Elm Grove, Watford, Herts., U.K.

⁴ Bettfield Clough Cottage, Castleton Road, Chapel-en-le-Frith, Derbyshire SK12 6PE, U.K.



Fig. 1. Map of distribution of *Leiostryla anglica* (Wood); based on UTM 50 km² grid squares. Closed circles represent sites used in this study; Open circles represent other records.

Hausdorf (1990) and Manganelli, Giusti & Della Cave (1990) and Pokryszko & Waldén (1992) refer to this work in their papers on *Leiostryla* species from the Mediterranean region.

Extensive field collecting in Morocco and Algeria was carried out in 1984, 1986, and 1988 as part of the research programme on the Systematics and Biogeography of the Land Mollusca of NW. Africa. All material collected is housed in the Zoology Department, National Museum of Wales (Abbr. post 1970 NMW.Z) in the Holyoak–Seddon Colln (HS). During this study, live material of *Leiostryla* was collected in Algeria. These shells seemed at first sight very similar to *L. anglica* (Wood, 1828) and this prompted re-examination of the status of *L. numidica* (Bourguignat, 1864).

VARIABILITY OF SHELL CHARACTERS

Material examined

Melvill-Tomlin Collection, National Museum of Wales (NMW 1955.158):

Leiostylia numidica, Blidah [=Blida], Algeria. 5 shells.

Leiostylia anglica, Algeria or Algerceras, Spain 1 shell [Ponsonby]

Holyoak-Seddon NW. Africa Colln, National Museum of Wales NMW.Z 1987. 001: HS# 1984.328.1, Azazga, E. of Tizi-Ouzou, Algeria

Holyoak-Seddon W. Palaearctic Colln, National Museum of Wales NMW.Z 1989. 097: HS# 1977.90.3, Sussex, England; HS# 1977.160.4. Sussex, England; HS# 1982.115.8.

Westmorland, England; HS# 1976.123.5. Argyll, Scotland; HS# 1976.115.8. Argyll, Scotland; HS# 1976.87.5. Argyll, Scotland; HS# 1976.88.5. Argyll, Scotland; HS# 1976.76.4. Argyll, Scotland; HS# 1976.109.4. Argyll, Scotland; HS# 1976.98.3. Argyll, Scotland; HS# 1976.77.3. Argyll, Scotland; HS# 1980.6.1. Kerry, Ireland; HS# 1980.36.2. Clare, Ireland; HS# 1980.34.8. Clare, Ireland; HS# 1982.54.1. Leitrim, Ireland; HS# 1982.59.1. Cavan, Ireland.

P. Tattersfield Colln. *Leiostylia anglica* El Bosque, 8.5 km W. of Grazelema, Prov. Cadiz, Spain, 36°56'N, 3°22'E; Rio Poquiera, below Pampaneira, Prov. Grenada, Spain, 36°56'N 3°22'E.

Great Britain and Ireland

Shells were examined from 16 sites ranging from Western Scotland to Sussex and Ireland. A representative selection of shells are shown in Fig. 2. There is variation in the shell shape, form of the apertural teeth and shell colour within populations and between sites.

(a) The shell shape varies mainly due to the relative width of the body-whorl, giving a more cylindrical base (Fig. 2a) to a conical form (Fig. 2b).

(b) The main variation in the apertural teeth is seen in the extent to which the main parietal tooth is linked to the edge of the lip. In some shells this tooth is relatively weak, with a slight callus linking (Fig. 2d), in others it is strong and straight with a prominent linking callus (Fig. 2a); it can also be curved towards the expansion of the lip at the superpalatal position reducing the apertural opening (Figs. 2b,c). The basal tooth is also variable in size; usually distinct and peg-like, but occasionally very weakly developed in some individuals within a population. There are, however, some shells which have two teeth in this position (Fig. 2a,d).

(c) It is possible to identify four forms of *Leiostylia anglica* which differed in shell colouration (on the body whorl). At most sites there was more than one form present within the population. However, the low number of shells from each site (57 shells scored from 16 sites) makes it difficult to do any statistical comparison. The forms recorded were:

(i) entirely pale brown (the commonest form; "var. *pallida*"); shells at 10/16 sites and at four sites this was the only form present.

(ii) entirely brown (fairly common); shells at 8/16 sites and at two sites this was the only form present.

(iii) dark brown on the upper two-thirds of the whorl, pale brown on the lowest one-third (fairly common; "form *castanea*"); shells at 5/16 sites.

(iv) entirely translucent whitish (uncommon unpigmented form; "var. *alba*"); shells at 1/16 sites.

In addition there is a fifth form which is only known as a Middle Pleistocene (Hoxnian) fossil in Britain (Hitchin tufa, Hertfordshire, England; cf. Kerney 1959). There are few intact shells of *L. anglica* from this deposit; material in NMW. comes from Kerney Colln. and the Holyoak-Seddon Colln. Of the 27 shells examined two complete adult shells have been recovered as well as juvenile and broken shells. The 9 shells which retain any colouration are referable to the below form:

(v) 'mid-banded' form, with the uppermost and lowermost thirds of the body whorl pale brown and the central third dark brown.

Spain

Material was collected from two sites in southern Spain by Peter Tattersfield in April 1992. These were identified as *Leiostyla anglica* and used for comparison with the material from Algeria. The records come from Prov. Grenada and Prov. Cadiz extending the known range in the Iberian peninsula (Seddon & Tattersfield 1992; Fig. 1). Again the material shows variation in shell form, apertural teeth and colouration.

The shells collected in Prov. Cadiz (UTM TF 86) were similar in shape to those from Grenada (Fig. 2 EF). Again the main variation was seen in the development of the apertural teeth. A very weakly developed small callus formed the basal tooth (Fig. 2 EF), in one shell it

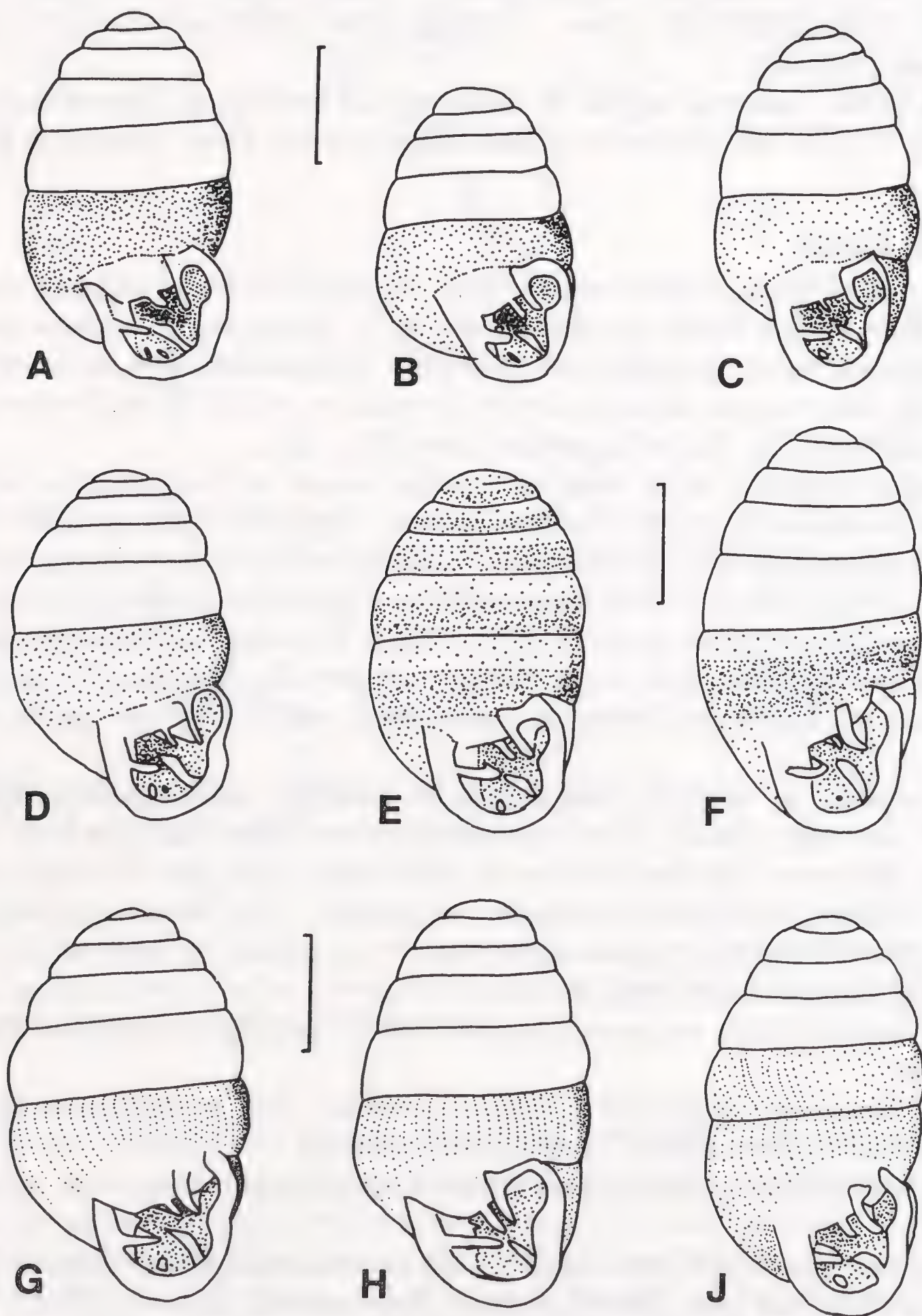


Fig. 2. *Leiostyla anglica* (Wood) from Britain and Spain (Scale Bar 1mm) Holyoak & Seddon W. Palaearctic Colln, National Museum of Wales NMW.Z 1989. 097: **A** HS# 1976.76.4. Argyll, Scotland; **BC** HS# 1976.77.3. Argyll, Scotland; **D** HS# 1982.54.1. Leitrim Ireland; P. Tattersfield Collection **EF** El Bosque, W. of Grazelema, Prov. Cadiz, Spain **GHJ** Rio Poquiera, Prov. Granada, Spain.

was almost absent. The extent to which the main parietal tooth is linked to the edge of the lip was variable. The prominent linking callus was not always present (Fig. 2F) although the upper parietal tooth was strongly developed, curving towards the expansion of the lip at the superpalatal position (Fig. 2). There was only one colour form present at this site; all shells were mid-banded similar to the form reported from Hitchin and Algeria (Fig. 2).

The shells collected in Prov. Grenada (UTM VF 79) were generally more uniform in shape (Fig. 2 GHJ), the body-whorl being fairly cylindrical. The main variation was seen in the development of the apertural teeth. Of the eight shells collected a peg-like basal tooth was visible in a front view of five shells (Fig. 2 GJ), in one shell it was absent (Fig. 2 H) and in the remaining two there was a very weakly developed small callus set well-back in the mouth (most evident in side-view). There were three colour forms present; var. “*pallida*” (6/8 shells), form “*castanea*” (1/8 shells) and 1 entirely brown shell.

Portugal

Nobre (1941) gives an illustration of a shell from Portugal. This shows that one of the colour morphs recorded is the form “*castanea*”. The shell shape and apertural teeth fall within the range recorded from Britain. Pokryszko & Waldén (1992) discuss the shell of “*Pupilla paulinoi*” Locard, 1899 described from Coimbra in Portugal and comment that, in their view, the shell description does not match the only preserved specimen seen.

Madeira

De Winter & Ripken (1988) recently discovered *Leiostylia anglica* on Madeira. Their illustrations for this shell show that the colour morph matches the form *castanea*, the same form that Nobre (1941) recorded from Portugal.

Algeria

The live-collected shells in the Djurdjura (Fig. 3) were compared with the material from Spain, the UK and museum material from Algeria. The shells were generally cylindrical with a tapering, conical apex. This is similar in form to the Spanish material and is within the range of variation for the UK. A basal tooth was present in one of the shells, a slight white area was seen in the position of the basal tooth in another, but in the remaining adult shell and in the museum shells (5 shells; Fig. 3 D,E) the basal tooth was absent. The upper parietal tooth was not always joined by a callus to the outer lip (Fig. 3B). The material live-collected in Algeria is a mid-banded form (Fig. 3), similar to the Algerian shell figured by Gittenberger & Pieper (1988). This banding type apparently formed the basis of Bourguignat’s (1864) “var. *unizonata*”. Bourguignat (1864) also recorded “var. *zonata*” from Algeria which implies that an unbanded form of *Leiostylia* occurs also, but this was not found in museum material. The description of var. *isserica* Letourneux, 1870 suggests that this is also a synonym of *L. anglica*.

ECOLOGY

Kerney & Cameron (1979) give the habitat of this species as damp places in woods and in marshes. The majority of the records in Britain are from the western parts of the country (Kerney 1976: Fig. 1) with many localities in Ireland. At many of the British localities the species was found amongst moss and leaves on damp ground in woodland with an understorey of herbs and sedges. The Spanish shells were collected from similar habitats intermediate elevations of between 430 and 800 m ASL. The earliest report from N. Algeria was from 1400 m elevation near Blida (Morelet 1853), with subsequent records from the

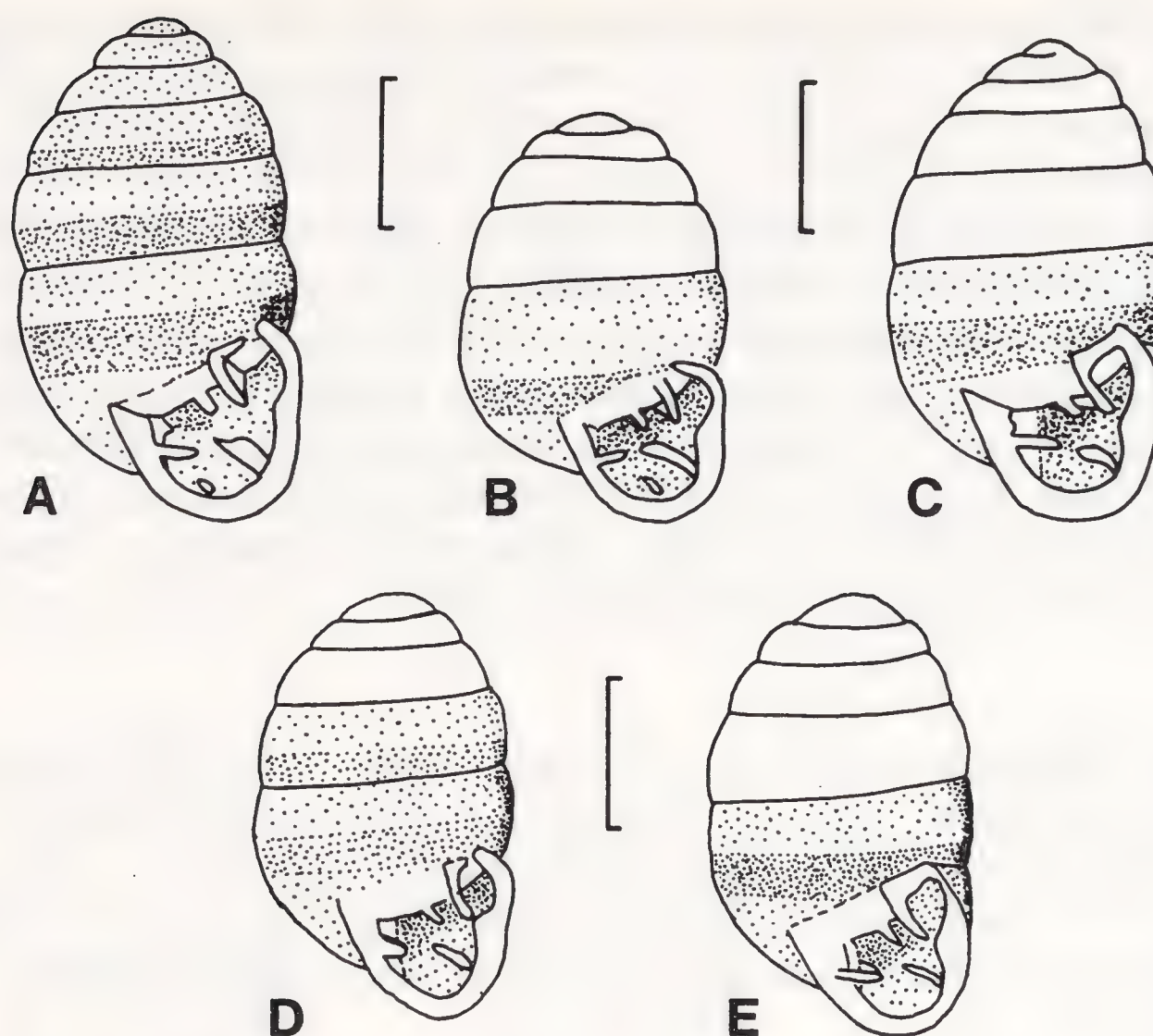


Fig. 3. *Leiostyla anglica* from Algeria. Scale Bar 1 mm.

ABC Holyoak & Seddon NW. Africa Colln, National Museum of Wales NMW.Z 1987. 001: (HS# 1984.328.1) Azazga, E. of Tizi-Ouzou, Algeria. DE *Leiostyla numidica*, Blidah [=Blida], Algeria. 5 shells; Melvill-Tomlin Collection, National Museum of Wales (NMW. 1955.158).

cedar forest at high elevations (Letourneux 1870). Letourneux (1870) gives detailed notes on the habitats: (a) among mosses, liverworts and herbs in shaded damp or wet places, often near springs on hillsides with schist or limestone bedrock, (b) at two sites he reported it from beneath the bark of fallen rotting trees in woodland. Our only Algerian record is from moist leaf-litter by a stream, beneath alder trees in woodland of deciduous and evergreen oak (840 m elevation). The data suggest that the species requires temperate, moist conditions which, in the southern part of the range, means the species is found only in coastal or montane regions where these conditions prevail.

TAXONOMIC NOTES

The main characters used to separate *Leiostyla numidica* from *Leiostyla anglica* are said to be shell shape and the absence of a basal tooth. Within the material described above a basal tooth was occasionally absent in shells identified as *L. anglica* from Prov. Grenada, Spain and weakly developed in some shells from Prov. Cadiz, Spain and the UK. In one shell of *Leiostyla* from Algeria a distinct but small basal tooth was present. This suggests that the presence or absence of the basal plica is an inconsistent character. This variability is common to other pupilloid species where within, for example, *Gastrocopta*, *Lyropupa* and *Vertigo*, the presence or absence of a basal plica varies for individual specimens. Although, occasionally in these genera the basal tooth may be bifid, within our material of *L. anglica* there were some shells with two distinct basal teeth, with the second tooth in a basal rather than the infra-palatal position. This inconsistency provides a strong argument against use of the presence/absence of the basal plica as a differentiating character. Pokryszko & Waldén (1992) commented on the variable nature of the callus between the angular tooth and the

palatal margin noting that *Leiostylia anglica* var. *gunhildae* (Westerlund, 1887) was described on the basis of absence of a callus. During the present study the lack of the callus was also noted in specimens from Spain and the U.K., but not with all specimens from a single locality. However, although the number of shells examined as a whole does not permit statistical analysis it shows that, as with other *Leiostylia*, the position and development of apertural teeth is very variable suggesting that caution is needed when using teeth as differentiating characters between species.

The shell size and shape is also very variable in all material from Britain, as was the extent to which striations are present on the shell. Full morphometric analysis would be required to demonstrate the view given by Pokryszko & Waldén (1992) that *L. anglica* is larger (with more whorls) than *L. numidica* as we believe their size ranges overlap. Pokryszko & Waldén (1992) also observed that the mid-banded form present in Algeria is only found in some specimens from the Iberian peninsula. However we have records of this form from the British middle Pleistocene and these are therefore different from those recorded in Britain today and show strong similarities to the Mediterranean shells (e.g. small basal plica and colour form like those from Algeria and Cadiz). Hence our comparisons of Algerian, Spanish and British shells show that they do not differ consistently in size, shape, presence/absence of apertural teeth or form (*contra* Bourguignat 1864, Kobelt 1899, Pilsbry 1922–1926, Gittenberger & Pieper 1988). As the main distinguishing shell characters for separating these species are shape and the absence of a basal plica, and both characters are variable, it is difficult to justify the separation of *L. numidica* even as subspecies. It is possible that examination of the genital anatomy of material from Algeria and Spain may result in further revision of the species or subspecies limits, but as shell characters are those which have hitherto been used to identify the species we consider *L. numidica* to be a synonym of *L. anglica*.

The illustrations of *L. anglica* given by Manganelli *et al.* (1990, Figs. 16, 17) are of the less common “form *castanea*”. These shells show little variation in the form of the apertural teeth (and are similar to the figure in Kerney & Cameron 1979), unlike the range of material which we figure, but the shells do show variation in shape (that is ovoid-conical to ovoid-cylindrical). We would agree with their conclusion that the fossil material illustrated of *Vertigo priscilla*, *Vertigo capellini* and *Leiostylia gottschicki* may be related to *L. anglica* as the characters used to separate these fossil species (including two basal teeth) are all characters which are variable.

BIOGEOGRAPHICAL IMPLICATIONS

It has long been recognised that there are two centres of diversity for this genus, the Atlantic Islands (especially Madeira) and in the Caucasus. The more widespread species, *L. anglica*, is present in part of the intervening region. *L. numidica* was previously regarded as a separate species, however the recognition that this is a synonym of *L. anglica* extends the eastern limit of the range of this species. *L. anglica* has a distribution that is ‘lusitanian’, i.e. Iberian peninsula, north to Ireland and Scotland, east to Algeria (Fig. 1). Its presence on Madeira is thought to be a recent introduction (de Winter & Ripken 1988). Similar patterns are repeated with other species such as *Plagyrona placida* (absent in the UK) and this distribution pattern is replicated in many plant species currently native in Ireland (P. Coxon 1993; pers. comm.). It is possibly surprising that there are no records of *L. anglica* as yet from Morocco, but this may be a real absence. This ‘lusitanian’ element of the Magreb fauna provides a contrast to the distribution patterns described by Giusti & Manganelli (1984), such as the circum-mediterranean patterns of genera in Pomatiidae, and the disjunct

distributions of the eastern mediterranean (*Hypnophila* spp., and *Poiretia* spp. from the Balkans, Italy, Sicily through to Tunisia and eastern Algeria). Giusti & Manganelli believed the latter patterns to have resulted from tectonic activity during the Tertiary.

We may speculate that the marked disjunction of the range of *Leiostyla* resulted from repeated occurrence of very cold climates in southern and south-western Europe during the Pleistocene, which caused fragmentation of a range that was previously more continuous. Certainly in Britain, *L. anglica* has not yet been recorded from the last interglacial (Ipswichian) but was present in the Hoxnian Interglacial. Then it was represented by the mid-banded form which is one of those currently recorded only in southern Europe and NW. Africa. This suggests that the limits of its range in NW. Europe has varied throughout the Pleistocene. These differences in the species reaching Britain (and Ireland) during the Ipswichian and other interglacial stages is also seen in other molluscan species, mammals and plants (R. C. Preece, A. P. Curren, P. Coxon, 1993, pers. comms.). The fact that *L. anglica* still occupies some of the intervening regions, between the two centres of diversity, would support this theory of range fragmentation. To examine the cause of fragmentation (e.g. tectonic activity is opposed to climatic change) requires further evidence.

The similarity of the shell form of *L. anglica* to the Miocene and early Pliocene fossils from southern Europe suggests a close relationship to the ancestral forms (Manganelli *et al.* 1990). These authors suggest that *Leiostyla* originated in central Europe and subsequently dispersed to SW., S., and SE. Europe, with isolation of *Leiostyla* on Madeira and the Caucasus resulting in speciation. Their time-scale for these events suggests isolation of the species in SE. Europe (Caucasus and Turkey) by the Upper Miocene. The origin of the Madeiran fauna is more problematic, some authors maintaining that the malacofauna is a relict assemblage of an early Tertiary western palaeo-arctic fauna (Waldén 1983), but Manganelli *et al.* (1990) are more cautious in suggesting a Mid-Tertiary colonisation. However, Pokryszko & Waldén (1992) are currently revising the *Leiostyla* from the Atlantic Islands, and their preliminary results indicate that some radiation occurred prior to colonisation of the Atlantic islands. This suggests that, although *L. anglica* may be close to the ancestral form, the evolutionary history of these species may be more complex, requiring several phases of speciation and colonisation of both SE. Europe and the Atlantic islands. Manganelli *et al.* (1990) also suggest that *L. numidica* became isolated in NW. Africa as the result of tectonic activity (microplate migration) during the Upper Miocene. As discussed above, the form present in Algeria is very similar to one of those present in Spain, and to the form present in Britain during the Middle Pleistocene. These similarities provide some evidence for range fragmentation due to climate change in the Pleistocene. Further studies of the anatomy and biochemistry of species from the two centres of diversity and the intervening regions are now required to assess their phylogeny.

Gittenberger's (1984) study of the Chondrinidae in southern Europe proposed that speciation resulted from adaptation to specific ecological niches within isolated areas during the Pleistocene. Our own studies of shell material from Madeira and Porto Santo show that this may also be a factor associated with speciation of *Leiostyla*. Although there is considerable variability in shell form of the apparent species, at any one site it is possible to separate a maximum of four shell "forms" which are currently given specific status. At the sites the "forms" usually occupy different microhabitats, such that only two species are strictly sympatric. Some of the more widespread species show considerable variation in shell shape, but apparently less variation in the position of the apertural teeth which therefore allows identification. For each species it is possible to define distinct habits so that some prefer (a) damp, grassy crags, (b) dry herbaceous ledges on crags, (c) ferns in woodland at intermediate and high elevations and (d) under tree bark in woodland. These ecological differences may also aid the separation into "species". On Madeira the island has a short geological history and it is likely that such geographical isolation could result from a

combination of steep ravines with isolated crags providing suitable habitats and lava flows isolating different regions.

CONCLUSIONS

The presence or absence of the basal plica is an inconsistent character in *Leiostyla* of NW. Europe as with other pupilloid species, and furthermore the shell is rather variable in shape. As these provide the two shell characters which separate *Leiostyla numidica* from *Leiostyla anglica*, we believe that there is currently insufficient evidence to maintain these as separate species.

ACKNOWLEDGEMENTS

Thanks are due to the Cheltenham & Gloucester College of Higher Education for support of the project through 1986–1989. Mr. Marcel Holyoak provided cheerful assistance in the field. The Nuffield Foundation provided a research microscope for the project. MBS completed this study at the NMW with support from the Leverhulme Trust. Dr. Beata Pokryszko and Dr. P. G. Oliver provided useful comments on this manuscript.

REFERENCES

- BOURGUIGNAT, J.-R. 1863–1864. *Malacologie de l'Algérie ou histoire naturelle des animaux Mollusques terrestres et fluviatiles recueillis jusqu'à ce jour dans nos possessions du nord de l'Afrique*. Paris, Challamel Aine. 2 vols., vol. 1: xi + 294 pp., 32 pl.; vol. 2: 380 pp., 26 pl. (Published in six fascicules between May 1863 and December 1864).
- DE WINTER, A. J. & RIPKEN, TH. E. J. 1988. *Leiostyla anglica* (Wood) on Madeira (Gastropoda, Pulmonata, Pupillidae). *Basteria*, **53**: 47–48.
- GITTENBERGER, E. 1984. Vicariantists and dispersalists among the Chondrinidae. In: Solem, A. & van Bruggen, A. C. (eds.). *World-wide Snails. Biogeographical studies on non-marine Mollusca*. Leiden: E. J. Brill/W. Backhuys: 56–69.
- & PIEPER, H. 1988. Eine Neue *Leiostyla*- Art aus dem Iran (Pulmonata: Pupillidae). *Arch. Molluskenk.* **119**: 65–71.
- GIUSTI, F. & MANGANELLI, G. 1984. Relationships between geological land evolution and the present distribution of terrestrial gastropods in the western Mediterranean region. In: Solem, A. & van Bruggen, A. C. (eds.). *World-wide Snails. Biogeographical studies on non-marine Mollusca*. Leiden: E. J. Brill/W. Backhuys.
- HANOTEAU, A. & LETOURNEUX, A. 1873. La Kabylie et les coutumes kabyles. Paris. vol. 1. [Malacology of Kabylie by Letourneux].
- HAUSDORF, B. 1990 (for 1989). Zur Kenntnis einiger Arten der gattung *Leiostyla* Lowe aus NW-Anatolien (Gastropoda; Lauriinae) *Arch. Molluskenk.* **120**: 65–71.
- KERNEY, M. P. 1959. An interglacial tufa near Hitchin, Hertfordshire. *Proc. Geol. Ass.* **70**: 322–337.
- & CAMERON, R. A. D. 1979. *A Field Guide to the Land Snails of Britain and north-west Europe*. Collins, London.
- & JUNGBLUTH, J. H. 1983. *Die Landschnecken Nord- und Mitteleuropas*. Verlag Paul Parey, Hamburg & Berlin, 384 pp.
- KOBELT, W. 1899. Rossmässler's "Iconographie der Land- & Süßwasser-Mollusken . . .". Wiesbaden, C. W. Kreidel, N. F., Bd 8. 111 pp., pl. 211–240.
- LALLEMANT, C. 1882. Liste de quelques Mollusques rencontrés sur l'Atlas au dessus de Blidah. In: C. Brongniart, "Excursion dans l'Atlas". *C. r. Ass. Fr. Avanc. Sci., Congres d'Alger* 1881: 1089–1091.
- LETOURNEUX, A. 1870. Excursions malacologique en Kabylie et dans le Tell Oriental. *Ann. Malac., Paris*, **1**: 258–322, p. 6.
- MANGANELLI, G., GIUSTI, F. & DELLA CAVE, L. 1990. Notulae Malacologicae XLVIII. Lauriinae (Gastropoda, Pulmonata, Orculidae/Pupillidae) from the Villafranchian of peninsular Italy. *Basteria*, **54**: 87–103.
- MORELET, A. 1853. Catalogue des Mollusques terrestres et fluviatiles de l'Algérie. *J. Conchyl., Paris*, **4**: 280–305.

- NOBRE, A. 1941. *Fauna malacologica de Portugale II Moluscos Terrestres a fluviais*. Mem. Estud. Mus. zool. Univ. Coimbra, **124**:1-277.
- PILSBRY, H. A. 1920-1921. *Manual of Conchology. 2nd ser., Pulmonata*. vol. 26. Pupillidae (Vertigininae, Pupillinae). Academy of Natural Sciences of Philadelphia. pp. iv + 254, 24 pl.
- POKRYSZKO, B. M. 1991 (for 1989). *Leiostyla adolfi* n. sp. (Gastropoda, Pulmonata: Pupillidae). *Arch. Molluskenk.* **120**: 155-162.
- & WALDÉN, H. 1992. Anatomical, biometric and phylogenetic studies of the genus *Leiostyla* (Gastropoda, Pulmonata). *Proc. 10th Intern. Malacol. Congr. Tübingen*: 565-570.
- ROLAND, E. & OTERO-SCHMITT, J. 1988. Gasteropodos terrestres: nuevas citas para Galicia. *Iberus*, **8**: 111-114.
- SEDDON M. B. & TATTERSFIELD, P. 1992. New distributional data for some land-snails from France and the Iberian peninsula. *J. Conch., Lond.* **34**:259-260.

LAND GASTROPODA OF NW. AFRICA: NEW DISTRIBUTIONAL DATA AND NOMENCLATURE¹

M. B. SEDDON² AND D. T. HOLYOAK³

(Accepted for publication, 16th January, 1993)

Abstract: The following represent new records for NW. Africa: *Catinella arenaria* (which greatly extends the known range), *Vertigo antivertigo*, *V. pygmaea*, *V. moulinsiana*, and *Pupilla triplicata*. The following species have not been previously recorded from Morocco; *Oxyloma pfeifferi*, *Vallonia costata*, *Toltecia pusillum*, *Helicodiscus singleyanus*, *Zonitoides nitidus* and *Zonitoides arboreus*. Examination of museum material suggests that there are species described from the region which may be conspecific with more widespread Palaearctic taxa for which we give new distributional records. The identities of *Vertigo discheilia*, *V. maresi*, *V. microlena*, *V. codia* and *V. briobia* (Bourguignat, 1864) are discussed. The following are synonyms of more widespread species: *Pupilla L'Eprevieri*' [= *Pupilla muscorum*], *Patula Marthae* Ancey, 1894 [= *Gittenbergia sororcula*]. Nomenclatural problems regarding *Helicodiscus singleyanus* are pointed out.

Key words: Biogeography, Morocco, Algeria

INTRODUCTION

The land Mollusca of the Magreb region has received little prolonged attention since the death of Pallary in 1937. Most of this paper is devoted to discussion of new distributional data acquired during our survey of the region (1984, 1986, and 1988). It is notable that many of these new records are of small species which are easily overlooked and have rather local distributions. A few of the records are based on the dissections of the animal where identification using shell characters is unreliable. Other new distributional records may simply be the result of recent introductions to NW. Africa. Certain nomenclatural problems have been encountered during the study and these are briefly discussed. For each species the new localities are given (including latitude and longitude co-ordinates; see also maps Figs. 1A & B). The habitats of these species are described and compared with those reported elsewhere in Europe. The majority of records are based on collections now lodged in the National Museum of Wales (NMW); a few records came from the private collection of Mr S. Tracey.

NEW RECORDS

Catinella arenaria (Bouchard-Chantereaux, 1838)

This species has similar external characters to *Succinea oblonga* (Draparnaud) and is difficult to identify using shell characters alone (Kerney & Cameron 1979). Therefore to differentiate reliably this species from *Succinea oblonga* the animals need to be dissected.

Specimens collected just N. of the Col de Tirouda, Djurdjura, Algeria (Fig. 1B) appeared

¹ Systematics and Biogeography of the Land Mollusca of NW. Africa. Contribution no 8.

² Department of Zoology, National Museum of Wales, Cathays Park, Cardiff, CF1 3NP.

³ Forwarding address c/o 22 Elm Grove, Watford, Herts., UK.

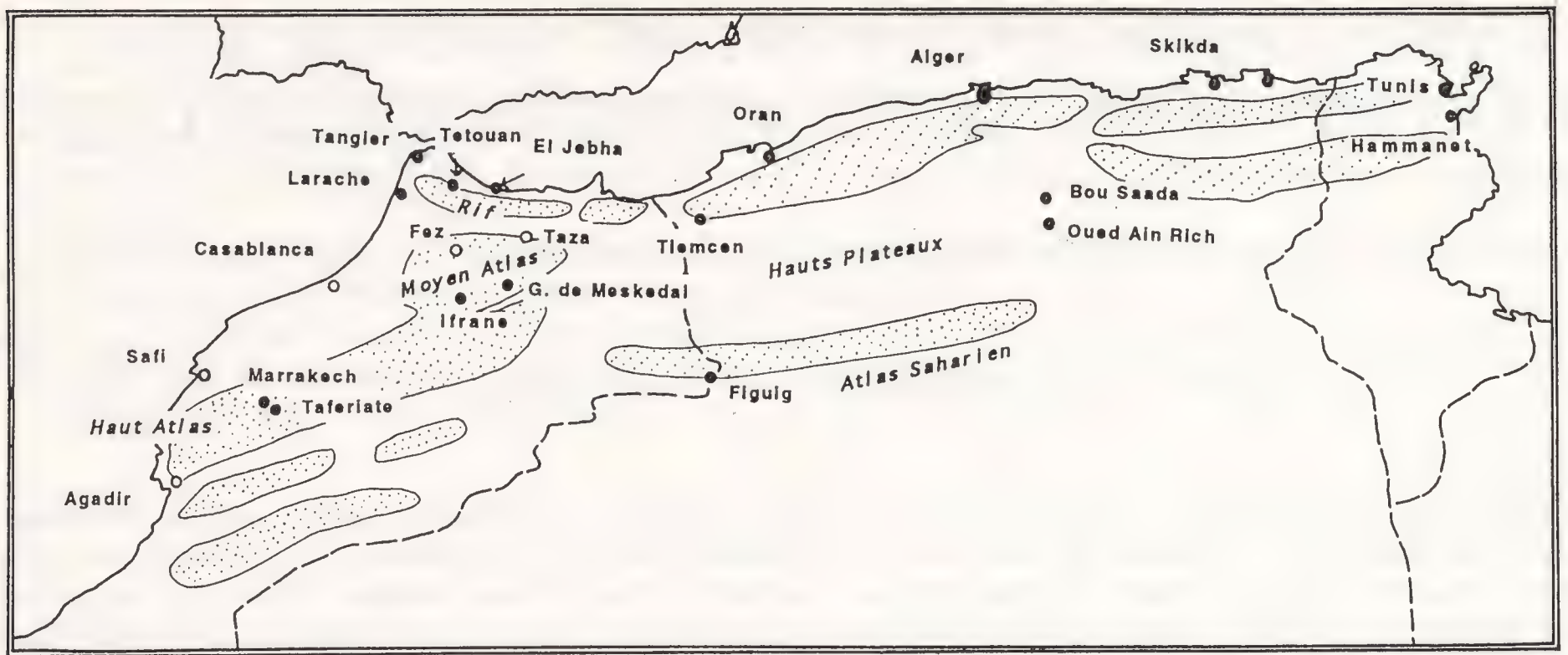


Fig. 1A. Map of NW. Africa showing localities in Morocco and Algeria. Shaded areas are mountain regions.

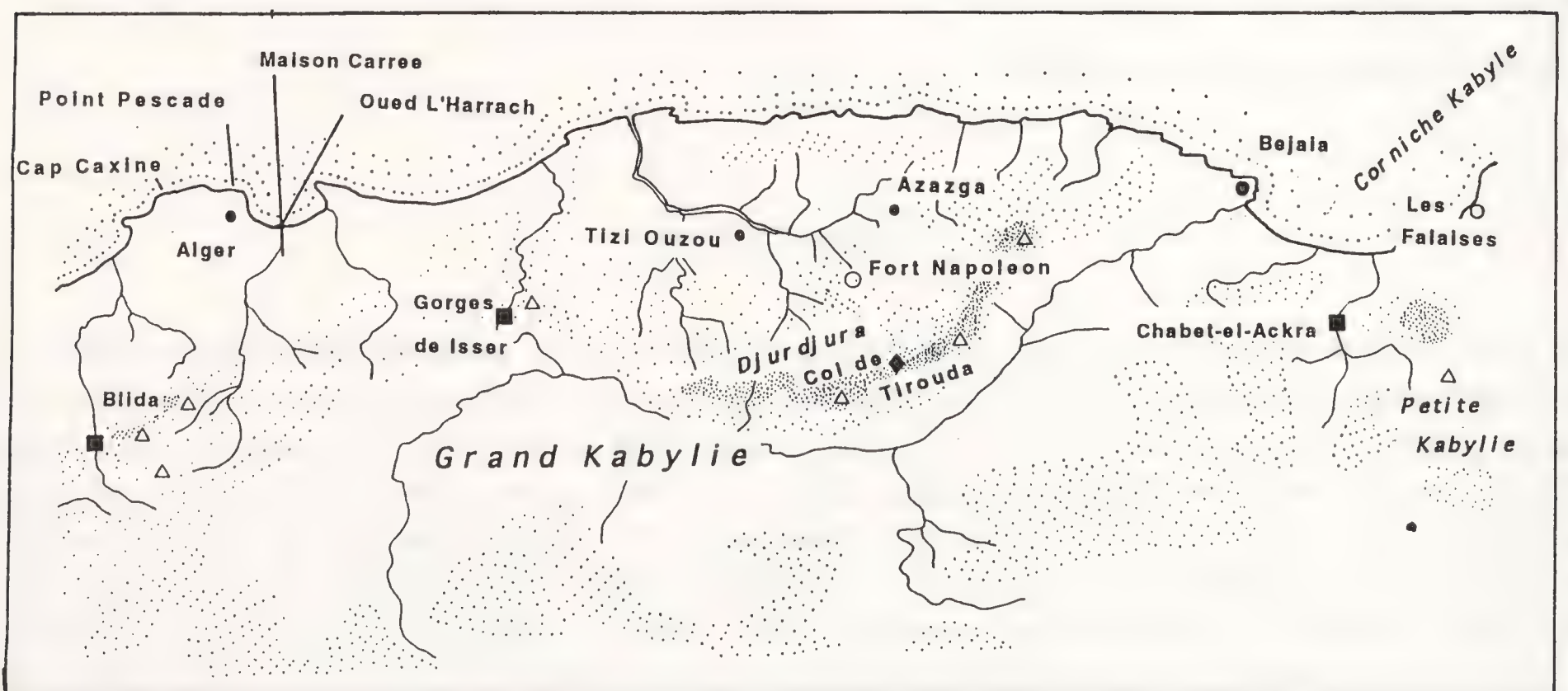


Fig. 1B. Detailed map of Grand Kabylie region to Alger.

to be externally similar to *Catinella arenaria* and were therefore dissected (Fig. 2A) These dissections confirmed these specimens as the first records of *C. arenaria* from NW. Africa. This record considerably extends the known range which consists of widely isolated sites in the mountains of central Scandinavia, eastern Switzerland and eastern-central Europe, and a few coastal sites around the southern North Sea and southern Baltic. In the British Isles it is restricted to a few fens in central Ireland and the north Pennines (Coles & Colville 1979) and dune slacks in Devon (Baker 1965).

The species was found high in the main mountain range of the Djurdjura in Northern Algeria (just below the col at 1860 m elevation). The site was a small spring on the steep siliceous hillsides. This provided a flushed area with bare mud patches within reeds (*Juncus*) with some grasses and herbs; mosses were present where the ground was wet. These specimens were collected from bare muddy patches within this flushed area. This habitat is similar to those where the species is found in Europe (calcareous mud in unshaded, damp, sparsely vegetated habitats of dune slacks, lowland fens, montane flushes or moist rocky places). There were only three other species found at this site; *Carychium minimum*, *Vertigo antivertigo* and *Lymnaea truncatula*.

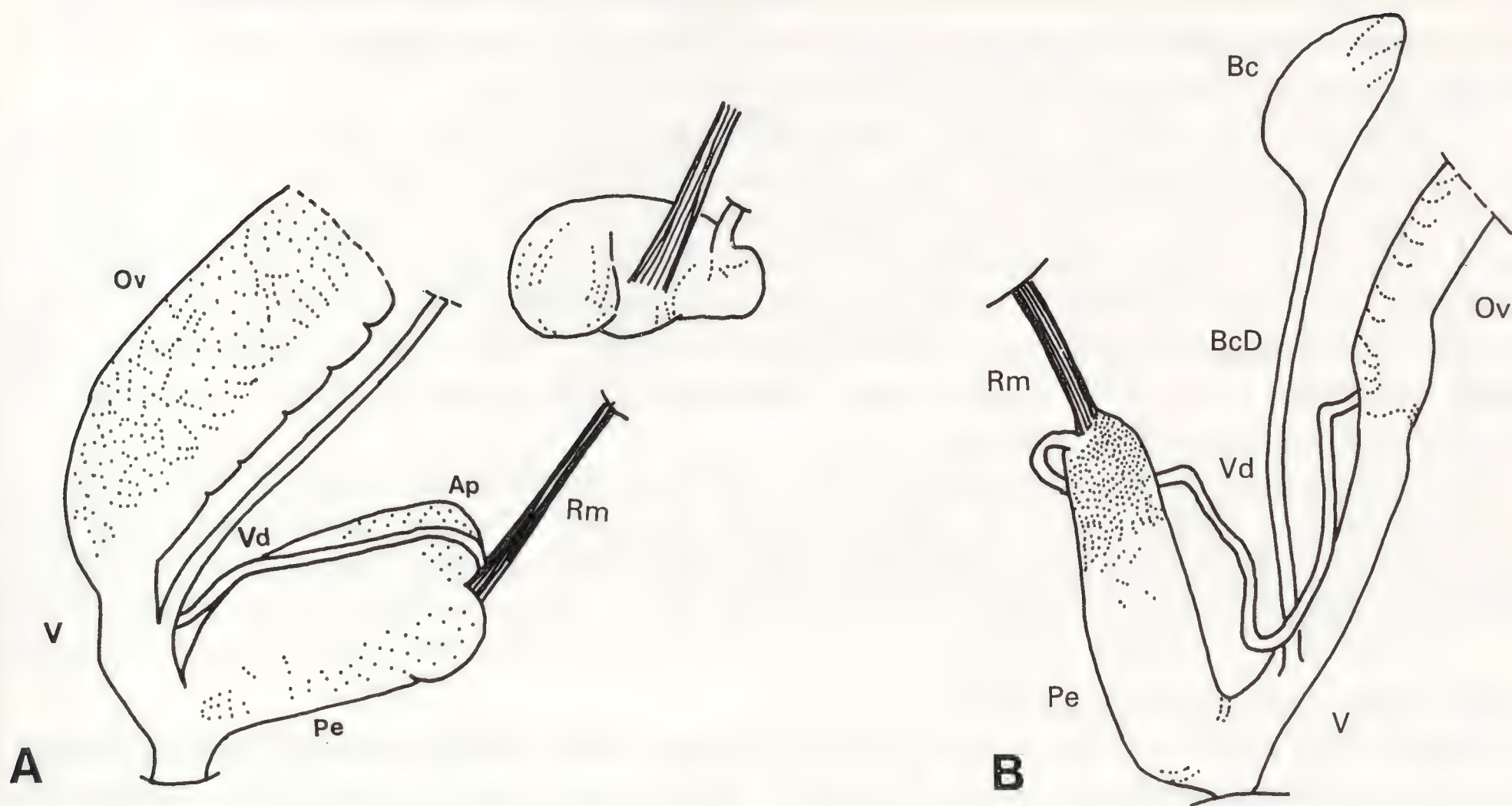


Fig. 2
A. Distal genitalia of *Catinella arenaria* from the Djurdjura mountains, Algeria.
B. Distal genitalia of *Oxyloma pfeifferi* from Larache, Morocco.

Abbreviations: Pe Penis, Rm Penial retractor muscle, Ap Penial appendage, V Vagina, Vd Vas deferens, BcD Bursa copulatrix Duct, Bc Bursa copulatrix, Ov Free Oviduct.

Oxyloma pfeifferi (Rossmässler, 1835)

O. pfeifferi has range which extends over almost all of Europe (including Iceland and arctic Scandinavia), through N. Asia eastwards to Siberia and S. Greenland (Kerney & Cameron 1979). As this species has variable shell characters, anatomical characters have been used to confirm that its presence in N. Morocco (Fig. 2B). The specimens were found in a grassy marsh near Larache (35°14'N, 6°06'W) at about 95 m elevation (Fig. 1A). There are other sites in NW. Africa where shells were found but no animals were available for dissection (near Taferiate in Morocco 31°31'N, 7°33'W at 870 m ASL, Fig. 1A; near Les Falaises on the coast in N. Algeria 36°39'N, 5°24'E at 30 m ASL, Fig. 1B). Shells were also preserved in Quaternary deposits of a wadi bed on the Hauts Plateaux well south in central Algeria (Oued Aïn Rich, south of Bou-Saada; 34°39'N, 4°04'E; Fig. 1A).

These records were all from grassy marshes with reeds (*Juncus*) and reedmace (*Typha*). Elsewhere in Europe the species has been found in fens, marshes, waterside vegetation and other permanently wet places. It withstands moderately acid conditions and considerable shading in scrub or carr woodland. The sites in NW Africa, therefore have similar habitats to those reported elsewhere.

Vertigo antivertigo (Draparnaud, 1801)

This species has a range covering much of NW. Europe through to Asia. In S. Europe there are scattered records from Portugal, Spain (from E. Pyrenees to Prov. València), Ibiza, Corsica, Sardinia, S. Italy, Sicily through to Yugoslavia.

We collected living *Vertigo antivertigo* from the coast at Les Falaises, Algeria (36°38'N, 5°21'E) and Merdja Zerga, (S of Larache), Morocco (34°52'N, 6°15'W) and the Djurdjura Mountains in Algeria (36°28'N, 4°21'E) (see *Catinella arenaria* above for habitat). Floodline debris collected by Mr S. Tracey at Hammanet in Tunisia provided fresh shells of this species, confirming that the species is also present in Tunisia. The habitats in these regions

were freshwater marshes with reedmace (*Typha*), grasses and herbs, thus differing slightly from typical habitats in Britain where the species usually favours sedges. These N. African records appear to represent the southern limit of the range.

Although Pallary (1898) records *Vertigo antivertigo* from Tangier, Morocco there are no records given by Bourguignat (1864) for Algeria. He described two species (*Vertigo discheilia* and *Vertigo maresi*) with similar shell characters from the region around Algiers (Maison Careé, Oued l'Harrach, la Rassauta). Letourneux (1870) gives records of these species from the floodline of Oued Saf-Saf near Phillipville [= Skikda] (Fig. 1B). Shells labelled *Vertigo discheilia* and *Vertigo maresi* in the Melvill-Tomlin Colln. (NMW) were comparable with *Vertigo antivertigo* from NW. Europe and Morocco. Type material should therefore be examined to confirm this synonymy.

These records show that the species has a scattered distribution mainly in the northern coastal regions in N. Morocco, N. Algeria and N. Tunisia. The species is also known as a Quaternary fossil on the Hauts Plateaux (see below), SE. Algeria (Ahaggar) and Egypt (Kharga) (Sparks & Grove 1961).

Vertigo pygmaea (Draparnaud, 1801)

The species has a holarctic distribution and is widespread in Europe, USSR, Siberia, Soviet Central Asia and eastern N. America. In S. Europe there are records from N. and C. Portugal, Spain (S. to Prov. Alicante, Seddon & Holyoak, unpublished data), Italy, and Yugoslavia. We have a late Quaternary record from wadi deposits of the Oued Aïn Rich (c. 100 km south of Bou Saada, Atlas Saharien 34°39'N, 4°04'E). Shells from floodline debris collected by S. Tracey at Hammanet confirmed that the species was once present in Tunisia.

Although no types have been examined our view is, that on the basis of similarity of illustrations and our shell material, *V. microlena* and *V. briobia* (Bourguignat, 1864) should both be regarded as synonyms of *V. pygmaea*. We have examined museum material from Algiers bearing these species names and these match our material of *V. pygmaea*. There are few literature records of these two species from the north coast of Algeria. Bourguignat (1864) gives records of *V. microlena* from Chabet-Beinan near Cap Caxine, Oued l'Harrach, Bone and Letourneux (1870) gives Oued Saf-Saf near Phillipville [= Skikda] (Fig. 1B) (these are mainly from river floodline debris, all of them might be Quaternary fossils).

Vertigo moulinsiana (Dupuy, 1849)

V. moulinsiana has a widespread but local distribution in N. Europe (Kerney & Cameron 1979). There are few records from S. Europe including southern France, Sardinia and Sicily. Bech Taberner (1979) found this species in Prov. Lerida, northern Spain, but there are apparently no confirmed records from southern Spain, although there are Holocene records from central Spain (Preece 1991).

Specimens of *Vertigo moulinsiana* collected from a grassy marsh near Larache in NW. Morocco (see above) extend the southern range of the species in the W. Mediterranean. This species has not previously been recorded from Morocco. However, examination of literature records of *Vertigo* spp. from NW. Africa shows that *V. codia* (Bourguignat, 1864) may be a synonym of *V. moulinsiana*. Specimens labelled "*V. codia* Bourguignat, 1864" from Alger were examined from the Melvill-Tomlin Colln. (NMW.1955.158) and found to be identical to *V. moulinsiana* from NW Europe and Morocco. Other species with similar characters include *Vertigo graellsiana*, which was recorded by Servain (1880) from river floodline debris in Zaragoza and Granada. Pilsbry (1918–20) also placed this taxon in the group which includes *V. moulinsiana* and commented that it was not clear how the species should be separated. The status of these two taxa requires confirmation and they may well prove to be conspecific. If so it would demonstrate a continuous, but local distribution for *Vertigo moulinsiana* through Spain to NW. Africa.

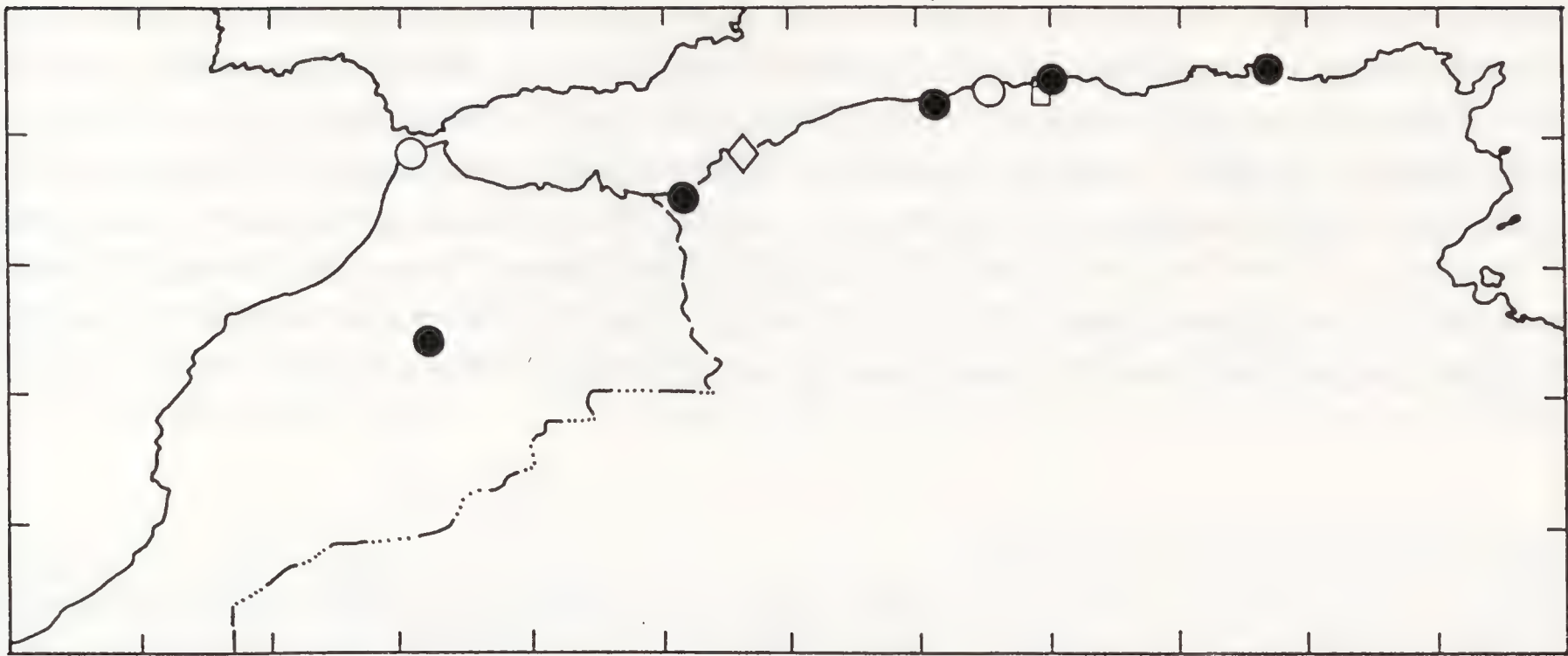


Fig. 3. Distribution of *Acanthinula aculeata* in NW. Africa. Closed circles, authors' recent records; Open circles, literature – recent records; Diamond published Quaternary record; Open square, authors' floodline record.

Pupilla triplicata (Studer, 1820)

The range of this species covers much of S. Europe from the Pyrenees, S. France and Alps eastwards to southern USSR (Kerney & Cameron 1979). There are a few records from Spain (Holyoak-Seddon Colln., unpublished data) but the species has apparently not been previously recorded from N. Africa. Recent work in the Moyen Atlas revealed its occurrence at one locality (c. 14 km S. of Timahdite, Morocco 33°07'N., 5°01'W; Fig. 1A) and it is possible that future work will provide more records of this montane species. The Moroccan shells do not differ in any way from shells from France and the Alps.

At the Moroccan locality numerous fresh shells were found at c. 1760 m elevation on ledges of an exposed limestone crag with patchy cover of grasses and herbs. *Lauria cylindracea* (da Costa) was living on the same ledges. This site is somewhat higher than those in NW. Europe.

Kerney & Cameron (1979) describe the habitat of this species as very dry exposed calcareous places such as limestone screes, mainly in mountain regions between 300 and 1000 m. Material in the Holyoak-Seddon Collection (NMWZ) shows that in NW. Europe the species was found between 110 m and 1330 m elevation. Most shells were recovered from limestone crags (or walls) which were either unshaded or partly shaded. At a few sites shade was provided by deciduous trees, but in the majority of sites vegetation cover was provided by bushes with grasses and herbs on rock ledges on the crags.

Acanthinula aculeata (O. F. Müller, 1774)

The only previous records of *A. aculeata* from Morocco were made by Pallary near Tangier (Pallary 1898, 1901, 1904) but there are other records from the montane regions near the coast in Algeria. This species was found at additional sites during this field survey extending the known range in Morocco (Fig. 3). Most records were from the coastal regions and the mountain regions near the coast. The sites were variable in geology from calcareous sandstone to siliceous rocks, mainly on rocky slopes, sometimes with low crags. The most inland record was from the Moyen Atlas at Aïn Leuh (33°15'N, 5°21'W) where the species was found at 1595 m elevation. The sites in Algeria varied in elevation from 100–510 m. Nearly all these sites were fully or partly shaded by evergreen oak with patchy shrubs and herbs beneath.

Vallonia costata (O. F. Müller, 1974)

This species was first reported from Algeria by Bourguignat (1862) who listed a Quaternary

record from the vallée de l'Oued-el-Biod near Geryville. A second record of the species, living under stones, came from Mostaghanem, Algeria (Coll. Brondel; Bourguignat 1863). Subsequent records were from river floodline deposits of the Oued Saf-Saf at Philipville [= Skikda] (Letourneux 1870). During this survey further shells were collected from Misserghin (SW. of Oran), where the species was found on a rocky limestone slope by a stream, partially shaded by trees and bushes. In Morocco this species was found living at Zaouia-d'Ifrane (at 1450 m elevation in Moyen Atlas, 33°33'N., 5°07'W; Fig. 1A). The specimens were collected in mature ash woodland beside a river which was flowing over tufa. The understorey was composed of many herbs, grasses and ivy (*Hedera*).

Plagyrona placida (Shuttleworth, 1852)

Gittenberger (1977, 1989) revised the species and synonymized *P. debeauxiana* from Lisbon in W. Portugal with it. The species was previously only known near Annaba, Algeria (Bourguignat 1863, Letourneux 1870, Gittenberger 1977). (Fig 4). In Algeria the species was reported from under leaves in humid and shady places (Bourguignat 1863: 184) and amongst hypnoid mosses covering oak trees, preferring uppersides of large horizontal branches (Letourneux 1870: 22). In contrast, our records from NW. Africa (and also Portugal and Madeira) were usually from rocky sites partially shaded by deciduous trees where the species was found above the ground on damp tree trunks or in leaf-litter.

Ena obscura (O. F. Müller, 1774)

There is very little information in the literature on the range of this species in NW. Africa (Gorges du Meskedal in N. Moyen Atlas, N. Morocco (Pallary 1929); Tlemcen and Annaba, N. Algeria). We report two modern records from the Moyen Atlas in Morocco (SE. of Zaouia-d'Ifrane, near Ifrane, 33°33'N, 5°07'W; Fig. 1A) and Mts. de Belezma in Algeria (Col de Telmet, WNW. of Batna, 35°36'N, 6°03'E). Thus this species has a very scattered and local distribution in Morocco and Algeria.

In NW. Africa *Ena obscura* has been recorded from detritus accumulated in crevices of rocks near a waterfall (Bourguignat 1864: 311–312) and rocky (schist) slopes (Letourneux 1870). Both new sites were close to streams. In Morocco the site was in a moist river valley covered by mature ash woodland with many herbs, grasses and ivy (*Hedera*). The Algerian record comes from a steep stream gully with exposed sandstone rocks at 1420 m elevation, shaded by holly (*Ilex*), evergreen oak and a few juniper bushes.

Toltecia pusillum (Lowe, 1831) = *Punctum pusillum*

The nomenclatural problems are considered in a separate note, meanwhile all references in this paper are given as *Toltecia pusillum* (Lowe, 1831).

The species recorded from Algeria as *P. poupillieri* (Bourguignat, 1863) is a synonym of *Toltecia pusillum*. We have a scattered range of localities in Algeria from Oran to Annaba. Shells from floodline debris of the Oued Martin near Tetouan (35°34'N, 5°19'W, Fig. 1A) are the first records for Morocco.

No habitat data is available for the Moroccan specimens and the European and Madeiran records are from disturbed habitats.

Helicodiscus singleyanus (Pilsbry, 1890)

Shells of *H. singleyanus* were found by sieving floodline debris of the Oued Martin near Tetouan in NW. Morocco (35°34'N, 5°19'W, Fig. 1A). This is apparently the first record for Morocco and NW. Africa.

The native range of *Helicodiscus singleyanus* in eastern and central U.S.A. where it is

widespread. In the Western Palaearctic it is known from a few widely scattered localities in Europe: S. Britain, France, Holland, Belgium, S. Switzerland, E. Germany, Austria, Hungary (Kerney, Cameron & Jungbluth, 1983), W. Pyrenees (Coles *et al.* 1983), N. Spain (DG 97, Gerona, Holyoak & Seddon 1985; WN 98, Navarra, Altonaga 1989) and more numerous records on the island of Madeira. It is probably introduced in the region as the first European record was not until 1943 (Kuiper 1956).

No habitat data are available for the Moroccan specimens although the European and Madeiran records suggest it lives partly underground, usually in disturbed habitats such as grassy roadsides and banks.

Discus rotundatus (O. F. Müller, 1774)

Material examined: Melvill-Tomlin colln., *D. abietinus* Kabylie, Algeria NMW 1955.158
This species has a widespread distribution in Europe from Scotland and S. Scandinavia southwards to Portugal, Spain, Sicily and S. Italy (Kerney & Cameron 1979). There are very few records given for Spain and these are mainly in the northern part of the country (Altonaga 1989). The species described from Algeria is *D. abietinus*, which is supposed to differ from *D. rotundatus* in the narrower umbilicus, proportionately wider body whorl, rounder shell mouth and especially the form of the lamellar ribs on the shell surface (Bourguignat 1863: 180–181). However, similar shells are said to occur in France, C. and S. Italy, Corsica and Sardinia (Germain 1930, Alzona 1971), and Uminski (1962: 318) also found them locally in N. France and Germany. Our comparisons of shells from various localities in Spain, France, Corsica and Italy show considerable variation in shape and sculpture, with a wide range of intermediates connecting the various forms (cf. Uminski 1962, Verdcourt 1985). Shells from Algeria (Melvill-Tomlin Colln. & Holyoak-Seddon Colln, NMW) resemble many of the European shells in shape but they differ more in sculpture, having notably tall and narrow ribs on the early whorls and more prominent granular microsculpture between the ribs (easily visible at $\times 50$ magnification). Nevertheless, some S. European specimens have equally prominent ribs and some have at least moderate development of the granular microsculpture, so it is doubtful if the Algerian populations merit separation even as a subspecies. This conclusion is partly based on the experimental work carried out by Boettger (1929, 1930, 1931) on the factors influencing shell morphology. He produced a form of *Discus* which closely resembled *abietinus* by rearing juveniles from typical German populations in constantly warm and moist greenhouse conditions. Within a single generation these snails developed the high spire, deep sutures, narrow umbilicus and last whorl only weakly joined to penultimate whorl. These characters were retained unchanged in later generations reared in the greenhouse. Boettger also showed that weakly pigmented shells (not the unpigmented 'albino' forms) developed in snails living in shaded heaps of stones, whereas normal richly-coloured shells developed in well lit sites close by. This suggests that the shell form of *Discus rotundatus* (including *abietinus*) may be controlled by environment in which development takes place, rather than being under genetic control alone.

The range of the genus *Discus* in NW. Africa appears to be restricted to the mountains of Kabylia, from near Blida eastwards to near Skikda in N. Algeria (Fig. 1A). Bourguignat (1863) noted that this rare species was found in leaf-litter, under stones and at the base of trees in 'almost all' of the montane forests of Kabylie. Letourneux (1870) found it living beneath the bark of dead and rotting trees in marshy woodland (of poplar, willow, alder and tamarisk) and in a moist ravine shaded by deciduous oak woodland. Our own records (Ait-Aissi, $36^{\circ}47'N$ $4^{\circ}25'E$, Azazga $36^{\circ}44'N$ $4^{\circ}24'E$; near Tizi-Ouzou) were from similar habitats at intermediate elevations in leaf-litter on moist shaded ground by small stream beneath alder within woodland of deciduous oak and on a ledge of a sandstone crag partly shaded by evergreen oak.

Oxychilus hydatinus (Rossmässler, 1838)

The species is known in N. Algeria (near Alger, Bourguignat 1864: 304, Riedel 1968: 497; E of Boghari, Bourguignat in Pechaud 1883: 24); new records from Misserghin, SW of Oran (Fig. 1A) extend the range to the west. The dead shells were found in rocky limestone areas partially shaded by bushes and herbs.

Zonitoides nitidus (O. F. Müller, 1774)

Although this species has been reported in Algeria (Westerlund 1886: 39, Pilsbry 1946) the source of this record is uncertain (cf. Riedel 1973, p. 60). It may be a Quaternary record as those elsewhere in southern Algeria (Ahaggar: Sparks & Grove 1961).

There is a new record for Morocco (SE. of Zaouia-d'Ifrane, near Ifrane in Moyen Atlas, 33°33'N, 5°07'W, Fig. 1A). The species was found living at 1450 m elevation in mature ash woodland beside a river which was flowing (in several small channels) over tufa. The understorey was composed of many herbs, grasses and ivy. The site contained other common NW. European species including some listed here. There are very few records of *Zonitoides nitidus* from the SW. part of the Iberian peninsula (Altonaga 1990a), but these show a scattered distribution including southern parts.

Zonitoides arboreus (Say, 1816)

A single find of two shells from Oued Martin near Tetouan in NW. Morocco (35°34'N, 5°19'W, Fig. 1A) apparently provide the first record for NW. Africa. This species is a native of N. America (from Canada southwards), Central America and West Indies. There are an increasing number of reports from the W. Palaearctic where the species has become established in a variety of habitats in Madeira and European USSR; many of the records from Europe are from greenhouses.

The Moroccan shells were found in river floodline debris and hence could have come from anyway within the catchment area.

Hawaiiia minuscula (Binney, 1840)

Norris (1986) provided the first record of this species from Morocco. There is now an additional record from floodline debris of Oued Martin near Tetouan in NW. Morocco (35°34'N, 5°19'W, Fig. 1A). In NW. Africa the records so far (garden, floodline debris) cannot be confirmed as occurring in natural habitats – the catchment of the Oued Martin contains town gardens.

Euconulus cf. *alderi* (Gray, 1840)

Many of the literature records pre-date the segregation of *Euconulus fulvus* and *E. alderi* so the literature records from Algeria are all *Euconulus fulvus* agg. Recent surveys of the Iberian peninsula allowed confirmation of *Euconulus fulvus* seg. (Altonaga 1990b). Specimens with characters of *E. alderi* were collected at two sites (1) near Larache in Morocco (see *Vertigo moulinsana*) and (2) Les Falaises in Algeria (see *Vertigo antivertigo*) The animals were live-collected and the body was a dark blackish-grey. Thus the identification is based on body colour and shell characters. These may provide the first records of this segregate from Morocco and Algeria. The habitats were marshes near sea-level, with grasses and herbs and reeds (*Juncus*; 1) or reedmace (*Typha*; 2) and are also typical of this species.

NEW QUATERNARY RECORDS

Shells preserved in Quaternary deposits of a wadi bed on the Hauts Plateaux well south in central Algeria (Oued Aïn Rich, south of Bou-Saada; 34°39'N, 4°04'E, Fig. 1A) provide

additional distributional information. The present vegetation was a sparse cover of herbs and occasional grass tussocks on a sandy plain supporting a mollusc fauna of *Sphincterochila* cf. *candidissima* (Drap.) and possibly '*Helicella*' cf. *saadensis* (Bgt.). The sequence was not datable, but the stratified deposits contained an assemblage including: cf. *Oxyloma pfeifferi*, *Cochlicopa* sp., *Vertigo antivertigo*, *Vertigo pygmaea*, *Granopupa granum*, *Vallonia pulchella*, *Euconulus* sp. and *Helix aspersa*. Some of these species are most likely to be found on damp grassland or marshes. Pollen analysis of organic-rich silts from the site showed that the species present were mainly Gramineae and Chenopodiaceae, which is consistent with this habitat, but yielded no information about the likely age of the deposits. Hence this assemblage suggests that this river floodplain and adjacent slopes had damp grassland areas or marshes at some stage during the Quaternary. The fauna contains some western Palaearctic species which formerly occurred further south than they do today.

NOMENCLATURAL NOTES

Pupilla muscorum (L., 1758)

Syn. *Pupilla L'Eprevieri* Pallary, 1927 *J. Conchyl., Paris*, **71**: 245–6. Pl.3, Fig. 36–38.

In NW. Africa this species is known from a few widely scattered records from N. Morocco, N. Algeria and N. Tunisia (Bourguignat 1864, Pallary 1926–1927). Numerous fresh shells labelled '*Pupilla L'Eprevieri*' Pallary from Laghouat (Pallary syntypes; Melvill-Tomlin Colln. NMW.Z 1955.158) are typical *P. muscorum*, some of them with a palatal tooth ('var. *bigranata*'). Most of the other records could perhaps be based on Quaternary fossils. There is one definite Quaternary fossil record from NW. Algeria (Bourguignat 1862).

Gittenbergia sororcula (Benoit, 1859)

Syn. *Patula Marthae* Ancey, 1894

Material examined: Melvill-Tomlin Colln., *Patula Marthae* Djurdjura (Ancey) Syntypes NMW.1955.158.

The systematic position of *Planogyra sororcula* has been the subject of debate and recently Giusti & Manganelli (1986) described a new genus *Gittenbergia* to include this species. In Europe *Gittenbergia sororcula* has a local distribution, mainly in mountains from SW. France, N. Spain and SW. Alps (in France) through to Italy, Sicily, S. Austria, Yugoslavia and Greece (Range Map in Prieto *et al.* 1986). Giusti & Manganelli (1986) give records from the Djurdjura Mountains of N. Algeria (Fig. 1B).

The original description of *Patula Marthae* Ancey, 1894 leaves little doubt that it is conspecific with *Gittenbergia sororcula*. This has been confirmed by examination of specimens of '*Marthae*' from the Djurdjura in the NMWZ and BM(NH) collections.

In Algeria, Ancey (1894) found specimens living at the base of small plants and in mosses growing in fissures of rocks around 1850 m elevation. Our only record is from grasses and herbs growing on a limestone crag at 1650 m elevation. Similarly, records from southern Europe are mostly from rocky limestone districts in mountain regions, often at moderately high elevations.

Helicodiscus singleyanus (Pilsbry, 1890)

Waldén (1983: 268) pointed out that *H. scintilla* Lowe, 1852 is a senior synonym of *singleyanus*, but he invoked art. 23b of the ICZN code [1961 ed.] to preserve the latter name. However, that article was only in force until 1 January 1973 [see 1985 ed. of Code, art. 79(c)(iii)]. This case should therefore be referred to the ICZN to preserve the use of the name *singleyanus*.

The Moroccan shells are apparently of the form *inermis* (which has a smaller, higher shell

with only weak traces of spiral lines). This has usually been treated as a subspecies, but Pilsbry (1948: 636) commented that they 'are so similar that their separation is most difficult'. Waldén (1983: 268) stated that in his opinion *H. inermis* is a distinct species, but he gave no diagnostic characters.

REFERENCES

- ALTONAGA, K. 1989. La familia Endodontidae Pilsbry 1894 (Pulmonata: Stylommatophora) en la Peninsula Iberica. *Kobie; Serie Ciencias Naturales Bilbao* No. **18**: 123–136.
- 1990a. Sobre *Zonitoides nitidus* en la Peninsula Iberica. *Çuardos de Investigacion Biologica*, **16**: 35–52.
- 1990b. *Euconulus fulvus* espezierari buruzko datu berriak Iberiar Penintsulan *Çuardos de Investigacion Biologica*, **16**: 1–22.
- ALZONA, C. 1971. Malacofauna Italica. Catalogo e Bibliografia dei Molluschi Viventi, Terrestri e d'Acqua Dolce. *Atti Soc. ital. Sci. Nat. & Civ. St. Nat. Milano*, **111**, 434 pp.
- ANCEY, C. F. 1894. Description d'une nouvelle *Helix* d'Algerie. *Le Naturaliste*, 1894: 44–45.
- BAKER, R. E. 1965. *Catinella arenaria* (Bouchard-Chantereux) at the Branton Burrows Nature Reserve, Devon. *Proc. malac. Soc. Lond.* **36**: 259–265.
- BECH TABERNER, M. 1979. Nuevos aportaciones al conocimiento de la fauna malacologica terrestre y de agua dulce de Cataluna. *Bol. R. Soc. esp. Hist. nat., (Biol.)*, **77**: 157–171.
- BOETTGER, C. R. 1929. Beeinflussung des Schalenbaues der Landschnecke *Gonyodiscus rotundatus* Müller. *Biol. Zbl., Leipzig*, **49** (9): 674–704.
- 1930. Untersuchungen über die Gewachshausfauna Unter- und Mittel-italiens. *Z. Morphol. Okol., Berlin*, **19** (2/3):
- 1931. Die Standortsmodifikation der Landschnecke *Gonyodiscus rotundatus* (Müller) Höhlen. *Mitt. Höhlen- u. Karstforsch., Berlin*, **2**: 50–54.
- BOURGUIGNAT, J.-R. 1862. *Paléontologie des mollusques terrestres et fluviatiles de l'Algérie*. Paris, Baillière et fils. 126 pp, 6 pl.
- 1863–1864. *Malacologie de l'Algérie ou histoire naturelle des animaux Mollusques terrestres et fluviatiles recueillis jusqu'à ce jour dans nos possessions du nord de l'Afrique*. Paris, Challamel Aine. 2 vols., vol. 1: xi + 294 pp., 32 pl.; vol. 2: 380 pp., 26 pl. (Published in six fascicules between May 1863 and December 1864).
- COLES, B. & COLVILLE, B. 1979. *Catinella arenaria* (Bouchard-Chantereaux) and *Vertigo geyeri* Lindholm from a base-rich fen in NW. England. *J. Conch., Lond.* **30**: 99–100.
- HOLYOAK, D. T. & PREECE, R. C. 1983. New distributional data on Land Mollusca from S. France. *J. Conch., Lond.* **31**: 259.
- GERMAIN, L. 1930, 1931. Mollusques terrestres et fluviatiles. *Faune de France*, **21**, **22**. Paul Lechevalier, Paris.
- GITTENBERGER, E. 1977. Beiträge zur Kenntnis der Pupillacea. VII. Über zwei wenig bekannte Valloniidae. *Zool. Meded., Leiden* **50**: 295–301.
- 1989. Additional data concerning the systematics and the remarkable ranges of three species of land-snail, known from Sintra. *Publ. Oças. Soc. Malac.* **13**: 13–16.
- GIUSTI, F. & MANGANELLI, G. 1986. Notulae Malacologicae, XXXIII. "*Helix*" *sororcula* Benoit 1859 and its relationships to the genera *Vallonia* Risso and *Planogyra* Morse (Pulmonata: Pupilloidea). *Arch. Molluskenk.* **116** [for 1985]: 157–181.
- HOLYOAK, D. T. & SEDDON, M. B. 1985. Non-marine Gastropoda from France, Spain and Italy. *J. Conch., Lond.* **32**: 67–70.
- KERNEY, M. P. & CAMERON, R. A. D. 1979. *A Field Guide to the Land Snails of Britain and north-west Europe*. Collins, London.
- , ——— & JUNGBLUTH, J. H. 1983. *Die Landschnecken Nord- und Mitteleuropas*. Verlag Paul Parey, Hamburg & Berlin, 384 pp.
- KUIPER, J. G. J. 1956. *Helicodiscus (Hebetodiscus) singleyanus inermis* H. B. Baker, neu für die europäische Fauna. *Arch. Molluskenk.* **85**: 163–169.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1985. *International Code of Zoological Nomenclature*. 3rd ed., adopted by the XX General Assembly of the Intl. Union of Biol. Sci. Berkeley & Los Angeles, Univ. Calif. Pr. for I.C.Z.N.
- LALLEMANT, C. 1881. Catalogue des mollusques terrestres et fluviatiles des environs d'Alger. *Feuille jeun. Nat., Paris*, **11**: 83–88.
- LETOURNEUX, A. 1870. Excursions malacologique en Kabylie et dans le Tell Oriental. *Ann. Malac., Paris* **1**: 258–322, pl. 6.
- NORRIS, A. 1986. Distributional records of land Mollusca from southern Morocco. *J. Conch., Lond.* **32**: 259–260.

SEDDON & HOLYOAK: LAND GASTROPODA OF NW. AFRICA

- PALLARY, P. 1898. Deuxième contribution à l'étude de la Faune malacologique du Nord-Ouest de l'Afrique. Supplément à "La Faune malacologique du Maroc" de A. Morelet. *J. Conchyl., Paris*, **46**: 49-170, pl. 5-9.
- 1901. Sur les Mollusques fossiles terrestres, fluviatiles et saumâtres de l'Algérie. *Mem. Soc. Geol. France, Paléontologie, Paris*, no. **22**: 213, pls. 4.
- 1904. Quatrième contribution à l'étude de la Faune malacologique du nord-ouest de l'Afrique. (Deuxième supplément à la "Faune malacologique du Maroc" d'Arthur Morelet). *J. Conchyl., Paris*, **52**: 5-58, pl. 1-3.
- 1926-1927. Compléments à la faune malacologique de la Berberie. *J. Conchyl., Paris*, **70**: 1-50, pl. 1-8 (1926); **71** (for 1927): 197-277, pl. 1-7 (1928).
- PECHAUD, J. 1883. *Excursions malacologiques dans le Nord de l'Afrique, de la Calle à Alger, d'Alger à Tanger*. I Paris 112 pp. (actually by Bourguignat).
- PILSBRY, H. A. 1939-1948. *Land Mollusca of North America (north of Mexico)*. Monogr. 3, Acad. Nat. Sci. Philadelphia. (vol. 1, part 1 1939, part 2 1940; vol. 2 part 1 1946, part 2 1948).
- PRIETO, C. E., MARTIN, R., GOMEZ, B. J. & LARRAZ, M. 1986. Nuevos datos sobre *Acanthinula* Beck 1846, *Planogyra* Morse 1864, y *Acicula* Hartmann 1821 (Molusca, Gastropoda) en la Peninsula Iberica. *Iberus* **6**: 257-264.
- PREECE, R. C. 1991. Radiocarbon-dated molluscan successions from the Holocene of central Spain. *J. Biogeogr.* **18**: 409-426.
- RIEDEL, A. 1968. Zonitidae (Gastropoda) Kretas. *Annls zool., Warsz.* **25**: 473-537.
- 1973. Catalogue des Zonitides (Gastropoda) du Maghreb. *Annls zool., Warsz.* **30**: 49-69.
- SERVAIN, G. 1880. *Etude sur les mollusques recueillis en Espagne et au Portugal*. Paris, St. Germain, D. Bardin, 172 pp.
- SPARKS, B. W. & GROVE, A. T. 1961. Some Quaternary fossil non-marine Mollusca from the central Sahara. *J. Linn. Soc. Lond.* **44**: 355-364.
- UMINSKI, T. 1962. Revision of the Palaearctic forms of the genus *Discus* Fitzinger, 1833 (Gastropoda, Endodontidae). *Annls zool., Warsz.* **20**: 299-333.
- VERDCOURT, B. 1985. The status of *Helix omalisma* Bgt. (Pulmonata: Discidae) *Conchologists' Newsletter* **93**: 272-279.
- WALDÉN, H. W. 1983. Systematic and biogeographical studies of the terrestrial Gastropoda of Madeira. With an annotated check-list. *Ann. zool. Fennici*, **20**: 255-275.

THE IDENTITY OF *TROPIDOPHORA* *HANNINGTONI* (SOWERBY III) (GASTROPODA: POMATIASIDAE)

B. VERDCOURT¹

(Accepted for publication, 12th December, 1992)

Abstract: The name *Tropidophora hanningtoni* is shown to apply to an operculate widespread in eastern tropical Africa and to also be no more than a race of *Tropidophora calcarea* although unfortunately the original provenance of this taxon is unknown.

Key words: *Tropidophora hanningtoni*, *Tropidophora calcarea*, Pomatiasidae, E. Africa.

INTRODUCTION

The genus *Tropidophora* Troschel has been in desperate need of a genuine critical revision (as against a mere compilatory monograph) for over a century or more but no one has been brave enough to undertake it. Only when the South African, East African, Madagascan and Mascarene species are compared together is the full extent of the problem realised. Many species, particularly some in Madagascar and the Mascarenes, are clearly very distinct, but several from each area look conspecific. Anatomical data are virtually non-existent and variation in shell size, shape, colour and sculpture seem phenomenal as the taxa are named at present. I suspect it would be easy to spend several decades on the problem without getting a really satisfactory result.

RESULTS OF PRESENT STUDY

Whilst attempting to name material from the Matumbi Hills, SE. Tanzania collected by Jonathan Kingdon and others for Frontier Tanzania I encountered the type of *Tropidophora hanningtoni* (Sowerby III) in the British Museum (Natural History). The specimen BM 1907.11.21.139, marked 'type' was part of a lot donated by S.I. da Costa. Sowerby (1889: 581, pl. 56, fig 14) gives the type locality merely as 'equatorial Africa' but although omitted from my check-list (Verdcourt 1983) it must have been collected in Tanzania. According to Gillett (1961: 209) Hannington, Anglican Bishop of East Equatorial Africa from June 1882 until May 1883, travelled from Saadani opposite Zanzibar, via Mpwapwa, to Uyui near Tabora and to Lake Victoria, returning by the same route. He was later martyred in Uganda (Verdcourt 1981). This type is undoubtedly identical with a fairly common coastal species usually called *Tropidophora calcarea* (Sowerby I). Connolly appears to have omitted any references to *Tropidophora hanningtoni* in his many papers on tropical African Mollusca but Von Martens (1897: 5) mentions it at the end of his account of *Cyclostoma letourneuxi*

¹ Spring Cottage, Kimbers Lane, Maidenhead, Berks., SL6 2QP.

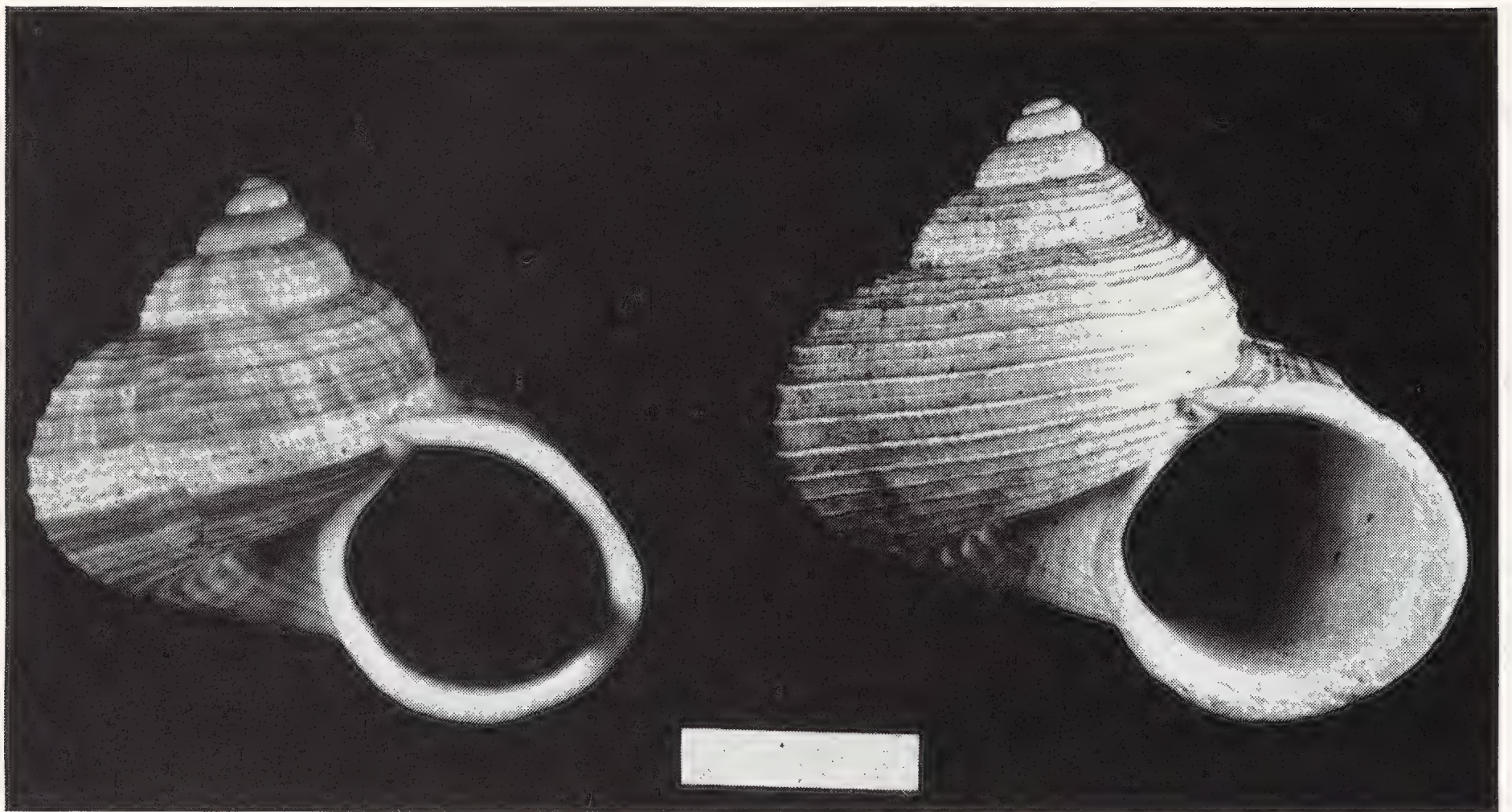


Fig. 1. *Tropidophora calcarea* (Sow. I). Kenya Coast. Left, Malindi, leg. S. Hill in CM 2763. Right, Kikambala, collector not known. (the white line represents 1 cm.)

Bourguignat var. *stuhlmanni* Von Martens stating “ohne nähere Fundortsangabe als Aequatorial-Afrika, ist dieser Form ähnlich, aber noch Grösser (24 mm breit, 23 mm hoch) [as against 21×20] mit mehreren Bändern und stärkerer Skulptur”. Von Martens gives the dimensions of *calcareum* as $27-30 \times 29-33$ mm.

It is necessary to consider the history of some other names. Lamarck (1822: 144) described a species *Cyclostoma sulcata* (sic – should be neuter – *sulcatum*) of which the provenance was unknown. Mermod in his account of Lamarck’s collection (1952: 35, fig. 103) figures the two syntypes preserved at Geneva which measure $29-31 \times 31-33.75$ mm. Lamarck’s name is pre-dated by *Cyclostoma sulcatum* Draparnaud (1805: 33) a well-known European species now placed in *Pomatias*. Lamarck’s species was later renamed *Cyclostoma calcareum* by Sowerby I (1847: 118, t. 26, fig. 113) also without knowledge of its habitat and this synonymy was repeated by L. Pfeiffer (1852: 201). I have examined Sowerby’s “Mus. Cuming” material which is the basis of his figure (BM 1951.3.8.1–3) and the shells measure $28-31 \times 29-32$ (the largest being wrongly marked type – he merely renamed Lamarck’s species) and certainly matches Mermod’s illustrations of *sulcatum*. The measurements for these shells of unknown origin are rather larger than those for *hanningtoni* but material I collected on Tongwe Mt. in Tanzania (see below) varied in size from 19×20 to 26×27 ; nevertheless I have seen no localised material as large as the types of *calcareum*. Connolly (1939, see below) gives the dimensions as 22.5×22.3 being based on material he had seen and clearly not including those of the types of the name he uses. It is possible that subspecies are involved.

The basic synonymy is set out below and other mentions in the literature are listed by Connolly (1912).

- 1822 *Cyclostoma sulcata* Lamarck (sic) (p. 144).
- 1847 *Cyclostoma calcareum* Sowerby I (p. 118, pl. 26, fig. 113); replacement name for *sulcata* Lamarck non Draparnaud.
- 1881 *Cyclostoma insulare* var.; *sensu* E. A. Smith (p. 277, pl. 32, fig. 1).
- 1889 *Cyclostoma hanningtoni* Sowerby III (p. 581, pl. 56, fig. 14).
- 1912 *Tropidophora calcarea* (Sowerby I); Connolly (p. 253).

1925 *Tropidophora calcarea* (Sowerby I); Connolly (p. 203).

1939 *Tropidophora calcarea* (Sowerby I); Connolly (p. 548, pl. 17, fig. 11).

Distribution: KENYA. Kilifi District: Malindi (H. Copley in CM F. 417; S. Hill in CM 2762-3) (NM) & Kikambala (collector not known) (NM). Mombasa District: Likoni (Jex-Blake in CM 2311) (NM) & Shanzu (C. G. Mann) (NM). Kwale District: Tiwi (Fowler) (NM) & 12 miles S. of Mombasa, Twiga, in forest and scrub on coral (Verdcourt) (NM).

TANZANIA. Handeni District: Genda Genda S. Forest Reserve (Frontier Tanzania) (BM). Tanga District: Tongwe Mt. (Verdcourt specimen CG) (NM). Pangani District: Msumbugwe Forest Reserve (Verdcourt specimen BF) (NM). Uzaramo District: 15 miles N. of Dar es Salaam, Wazo Hill (Kasigwa) (DSM) (small specimen much below the usual dimensions) & near Dar es Salaam, Pande Forest Reserve (Frontier Tanzania) (BM). Rufiji District: Mchungu Forest Reserve (Frontier Tanzania) (BM). Kilwa District: Matumbi Hills, 1000-1750 ft. (Kingdon) (BM). Lindi District: Lager Kitohai, 26 km SW. of Sadi Makanjila on the plateau between the rivers Lukuledi and Mbemkuru, Distr. Magao (Lieder) (B).

MOZAMBIQUE: Mozambique (Gibbons) (? ubi). Tette (Kirk; Thomson) (BM). (Museum abbreviations are as follows B (Zoological Museum, Berlin); BM (British Museum (Natural History)); DSM (University of Dar es Salaam); NM (National Museum of Kenya, Nairobi, formerly Coryndon Museum)).

As mentioned above Von Martens compared *hanningtoni* with his *Cyclostoma letourneuxi* var. *stuhlmanni* but I examined the type of the latter in Berlin in the 1950's and it is certainly not related, belonging to the group having a smooth area between the upper and lower groups of ridges rather than being ridged all over.

ACKNOWLEDGEMENTS

I am indebted to J. W. H. Hancock and F. Woodward of the Natural History Department, Art Gallery and Museum, Kelvingrove, Glasgow for prints taken from negatives I had deposited in their department. My thanks are also due to Dr. Peter Mordan, Mollusca Department, British Museum (Nat. Hist.) for allowing me to consult the collections and library.

REFERENCES

- CONNOLLY, M. 1912. A revised reference list of South African non-marine Mollusca; with descriptions of new species in the South African Museum. *Ann. S. Afr. Mus.* **11**: 59-306.
 — 1925. The non-marine Mollusca of Portuguese East Africa. *Trans. R. Soc. S. Afr.* **12**: 105-220.
 — 1939. A monographic survey of South African non-marine Mollusca. *Ann. S. Afr. Mus.* **33**: 1-660.
 DRAPARNAUD, J.-P.-R. 1805. *Histoire naturelle des mollusques terrestres et fluviatiles de la France*. Paris.
 GILLET, J. B. 1961. The history of the botanical exploration of the area of 'The Flora of Tropical East Africa' (Uganda, Kenya, Tanganyika and Zanzibar). *Comptes rendus de la iv^e réunion plénière de l'AETFAT*: 205-229.
 LAMARCK, J. B. P. A. DE M. 1822. *Histoire naturelle des animaux sans vertèbres*, 6(2).
 MERMOD, G. 1952. Les types de la collection Lamarck au Muséum de Genève (3). *Revue suisse Zool.* **59**: 23-97.
 PFEIFFER, L. 1852. *Monographia pneumonopomorum viventium*. Cassel.
 SMITH, E. A. 1881. On a collection of shells from Lakes Tanganyika and Nyassa and other localities in East Africa. *Proc. zool. Soc.* 1881: 276-300.
 SOWERBY, G. B. (I) 1847. *Thesaurus Conchyliorum, or monographs of genera of shells*, 1. London.
 SOWERBY, G. B. (III) 1889. Description of thirteen new species of land-shells with a note on *Buliminus fulminans*. *Proc. zool. Soc.* 1889: 577-582.

- VERDCOURT, B. 1981. Collectors in East Africa – 3. James Hannington (1847–1885). *Conch. Newsl.* **77**: 317–318.
- 1983. A list of the non-marine Mollusca of East Africa (Kenya, Uganda, Tanzania, excluding Lake Malawi). *Achatina* (11); 200–239.
- VON MARTENS, E. 1897. Beschalte Weichtiere Deutsch-Ost-Afrikas in Möbius, Deutsch Ost-Afrika 4(1), 308 pp. Berlin.

OBITUARY

VERA FRETTER (1905–1992)

Dr Vera Fretter's name is well known as co-author of *British Prosobranch Molluscs* (written with Professor A. Graham) and published by The Ray Society in 1962. This is a much valued reference source amongst mollusc specialists and zoologists generally. She joined the Conchological Society of Great Britain and Ireland in 1966 and although she did not attend meetings or publish in the *Journal*, members of the Society seriously interested in marine prosobranchs had frequent cause to be grateful to her for opinions on specimens and encouragement in their research.

Dr Fretter died at her home in Purley near Reading on 15 October 1992 at the age of 86; obituaries have already appeared in *The Independent* (12 November 1992) and the *University of Reading Bulletin* No 258, December 1992, both written by her colleague in the Zoology Department, Professor Alastair Graham.

Those of us who knew Dr Fretter and had the privilege of working with her in the University of Reading, will remember her as a first-rate teacher – full of enthusiasm and presenting her material in a lively and enjoyable way. Having “done” *Mytilus*, or whatever animal, with Dr Fretter was to know it inside out as she provided both a firm framework for knowledge and precise detail. She always believed in the importance of practical work, in



VERA FRETTER (1905–1992)

learning from first hand experience, making your own accurate observations on the specimens and when in dispute with a book, pointing out that “the animal is always right.” Teaching was seen as a learning process too, and when a research student tried to get out of demonstrating a particular practical on the grounds of lack of knowledge of the animals covered, this was invariably unsuccessful and Dr Fretter would retort that “the best way to learn something was to teach it.” The foundations for Dr Fretter’s standing as a teacher were laid early on.

She was brought up in Plumstead in London and went on to train at Furzedown College and thence to teach in a primary school in a poor area of south-east London. During her teacher training she was attracted to both natural history and art, and indeed in her later career the drawing ability was extensively used and became almost a hallmark of her publications, as well as on the blackboard in the classroom situation. She was encouraged by an HMI to undertake further training and whilst teaching in school, studied for a zoology degree in the evenings at Birkbeck College where she obtained a first class B.Sc. This led to the continuation of her studies full-time and a doctorate in 1936. Dr Fretter’s university career was at Royal Holloway College, Birkbeck College (University of London) and the University of Reading, from 1954.

Dr Fretter was an active researcher of international reputation whose painstaking work added much to our knowledge and understanding of the function and structure of prosobranch molluscs through her many publications. Functional morphology was the theme of the Reading malacology school. She was also interested in the pelagic larval stages and to obtain live plankton samples, she worked at marine laboratories both in Britain and overseas. The quality of her research was soon recognised by the post of Reader in the Zoology Department at Reading.

Another most important influence which Dr Fretter had was as supervisor of many research students working for masters and doctorates, of whom the writer was one. Some of them came from distant parts of the world to work under Dr Fretter for a higher degree and she went out of her way to make them welcome and help them to settle to life in Reading and cope with their language difficulties.

Although she officially retired from the University in 1970, she kept on a research room in the Department of Zoology and was active to the end, with her own work on prosobranch molluscs and in helping and advising others. Together with Professor Graham with whom she had collaborated for many years, *British Prosobranch Molluscs* was substantially revised, some chapters re-written and one of her last tasks was the correction of the proofs. Sadly she did not live to see its publication.

Dr Fretter was a person who enjoyed life – her work was always a source of immense pleasure and she also took delight in travelling and visited many parts of the world and had a wide network of malacological friends. For relaxation she enjoyed gardening, and Dr Alison Kay from Honolulu recalls how Dr Fretter immediately pitched in to help in her garden in Honolulu when she was staying. Dr Fretter always had time for, and a great interest in, people and eagerly received news of her old students.

At a time when the more traditional aspects of zoology have often been displaced, Dr Fretter will be missed for her particular vision of the zoological world.

Use is acknowledged of factual data from Professor Graham’s obituaries.

JUNE CHATFIELD

COMMUNICATIONS

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Opinions published in the Bulletin of Zoological Nomenclature

The following Opinions were published on 30 September 1992 in Vol. 49, Part 3 of the *Bulletin of Zoological Nomenclature*.

Opinion 1690. *Helix (Helicigona) barbata* Férussac, 1832 (currently *Lindholmiola barbata*; Mollusca, Gastropoda): lectotype designation confirmed.

Opinion 1691. *Polygyra* Say, 1818 (Mollusca, Gastropoda): *Polygyra septemvolva* Say, 1818 designated as the type species, and POLYGYRIDAE Pilsbry, 1895 given precedence over MESODONTIDAE Tryon, 1886.

Applications published in the Bulletin of Zoological Nomenclature

The following applications were published on 17 December 1992 in Vol. 49, Part 4 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these Applications is invited for publication in the *Bulletin*, and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

Case 2833

***Tortaxis* Pilsbry, 1906 and *Allopeas* Baker, 1935 (Mollusca, Gastropoda): proposed conservation by the designation of a neotype for *Achatina erecta* Benson, 1842.**

Fred Naggs

Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

Abstract. The purpose of this application is to conserve the usage of the subulinid land snail generic names *Tortaxis* Pilsbry, 1906 and *Allopeas* Baker, 1935, and that of the specific name of *Achatina erecta* Benson, 1842. When establishing *Tortaxis* Pilsbry designated *Achatina erecta* as the type species but he was accepting a misinterpretation of this species and in fact dealing with *Spiraxis mandarinus* Pfeiffer, 1855 (originally included as a nominal species but since synonymized with '*A. erecta*'). The syntypes of *Achatina erecta* Benson are specimens of *Bulimus gracilis* Hutton, 1834, the type species of *Allopeas*. It is proposed that usage be maintained by designating a neotype for *A. erecta* in the established sense.

Case 2845

***Taningia danae* Joubin, 1931 (Mollusca, Cephalopoda): proposed precedence over *Taningia persica* (Naef, 1923)**

Michael Vecchionie

National Marine Fisheries Service, Systematics Laboratory, National Museum of Natural History, Washington. D.C. 20560, U.S.A.

Clyde F. E. Roper

Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institute, Washington, D.C. 20560, U.S.A.

Abstract. The purpose of this application is to conserve the usage of the specific name of *Taningia danae* Joubin, 1931, a cosmopolitan large deep-sea squid which is a major food of sperm whales. A small paralarval specimen originally named as *Octopodoteuthis persica* Naef, 1923 certainly belongs to *Taningia* and probably to the only recognized species, *T. danae*; the name *persica* never has been used as valid.

MONODONTA LINEATA (DA COSTA) FROM ARCHAEOLOGICAL SITES IN DORSET AND THE ISLE OF WIGHT

Monodonta lineata is the most conspicuous of the top shells, since it is common at the upper limit of the mid-littoral zone and can be found in the open on bare rock amongst a thinly distributed cover of barnacles (*Chthamalus*) and brown algae such as *Fucus spiralis*. Its greatest number occur on partly sheltered rocky shores and is less common on

steep slopes, unless there are many cracks and ledges. It is remarkably tolerant of wave action but avoids areas that are muddy or that have a heavy cover of fucoids. Although *Monodonta* is abundant throughout most of the western half of the English Channel, it becomes increasingly rare east of Lyme Regis (02°55'W) in Dorset. On the French coast its range extends much further east, where it is present in small numbers east of the Côtentin peninsula, but is absent from most of the Normandy coast (Crisp D. J. & Southward, A. J. *J. mar. Biol. Ass. UK* **37** (1958) pp. 157–208).

The eastern limit of distribution of *M. lineata* in the Channel has been discussed by Hawthorne (*J. Conch., Lond.* **25** (1965) pp. 348–352) who carried out survey work both before and after the severe winter of 1962–3. He showed that before the severe winter small populations of *Monodonta* occurred east of Portland as far as Chapman's Pool (02°04'W) and that all of these specimens (except one) had maximum shell diameters of 2 cm or more. This suggests that unusual conditions in one year may have allowed the successful dispersal and settlement of larvae from a viable population further west. However, Kendall (*J. moll. Stud.* **53** (1987) pp. 213–222) in a larger survey of sites in SW. England and Wales, showed that the absence or particularly poor representation of year classes was exceptional and was restricted to sites where local factors were particularly severe. All the populations east of Portland were eliminated during the severe winter and those to the west were considerably reduced (Hawthorne *op cit.*, Crisp, D. J. & Southward, A. J. *J. Anim. Ecol.* **33** (1964) pp. 179–183). Since 1963 only a single specimen of *Monodonta* (from Osmington collected on 16 June 1990 by J. M. Light) has been found alive east of Portland. Lyme Regis is now considered the most easterly 'permanent' population, with occasional settlement in the Golden Cap area (thriving here in June 1992), often adversely affected by coastal mud-slides, and at West Portland, which is an exposed shore. Dense populations of *Monodonta* can therefore occur close to the species' distributional limit.

Historical records and archaeological evidence suggests that *Monodonta* was formerly much commoner east of Portland. Mansel-Pleydell (1898) in his *Mollusca of Dorsetshire* lists records from Lulworth Cove and from Kimmeridge Bay, where it was said to be plentiful on rocks in the *Laminaria* zone. *Monodonta* shells were also present in a Mesolithic midden, radiocarbon-dated to between 5–6000 years BP, in the tufa at Blashenwell Farm near Corfe Castle (Preece, R. C. *J. archaeol. Sci.* **7** (1980) pp. 345–362). Clement Reid's (*Proc. Dorset nat. Hist Antiq. Fld Club* **17** (1896) pp. 67–75) record of "*Gibbula tumida*" from the same deposit is almost certainly an error for *M. lineata* (Preece, R. C. 1980, *op cit.*). Although we can never know the harvesting site of the Blashenwell shells, Reid speculated that the most likely source was probably somewhere in the neighbourhood of Chapman's Pool, about 3 km south of Blashenwell. As mentioned earlier this site represents the easternmost English locality where *Monodonta* has been found alive this century.

There are no living records of *M. lineata* from the Isle of Wight. During the recent survey of the marine molluscs of the Island, currently being undertaken by I. J. Killeen and J. M. Light, only two dead shells have been found, the first at St Helens (SZ 638894) on 12th September 1987 and the second on the single spit off Puckpool (SZ 61/92) collected on 6th April 1991. The occurrence of *Monodonta* in two archaeological sites near Ventnor (01°12'W) on the south coast of the Island is therefore noteworthy.

The first site is at Binnel Point (NGR SZ 52537579) where a few marine shells were recovered from a Neolithic soil horizon buried by landslip debris (Preece, R. C. *J. archaeol. Sci.* **13** (1986) pp. 189–200). These included some small fragments of a trochid, originally identified as "*Gibbula* sp", but now thought to be *Monodonta*, because of the pattern of pigmentation and the porous nature of its shell that matches reference material of this species. A radiocarbon date of 4700 ± 140 BP (BM-1737R) has been obtained from charcoal from a lower soil horizon, immediately below the level with the *Monodonta* (Preece, R. C. (1986) *op cit.*; Bowman, S. G. E. *et al.*, *Radiocarbon* **32** (1990) pp. 59–79).

The second site is Watcombe Bottom (NGR SZ 544773), the dry valley between Week Down and Rew Down about 2 km NW of Ventnor. The valley floor has recently been levelled to create some playing fields for Ventnor Football Club. Towards the head of the valley are sections cutting through chalky colluvium of Late-glacial age above which, on the western side, are younger Post-glacial slope deposits. In addition to land snails, such as *Pomatias elegans*, these upper deposits have also yielded abundant marine shells, especially limpets (*Patella vulgata*) and winkles (*Littorina littorea*). Several adult *Monodonta* shells were also recovered. The age of this midden is not yet known, although a Bronze Age date would seem likely in view of the occurrence artefacts of this date in the immediate area (Basford, H. V. 1980, *The Vectis Report, A survey of Isle of Wight Archaeology*, I. W. County Council).

The inescapable conclusion is that *M. lineata* not only occurred, but was frequent on the rocky shores of the Undercliff as recently as the Neolithic and Bronze Age. Although The Undercliff has suffered major landslipping which would have affected several beaches, it is doubtful whether the present absence of *Monodonta* can be attributed to local factors of this kind. Indeed, several beaches along this stretch of coast would still seem to provide suitable habitats for *Monodonta*.

In view of its known sensitivity to cold winters, perhaps an alternative climatic explanation might be invoked. In Britain its present distribution extends north only as far as Anglesey but in Ireland it extends along much of the west coast reaching slightly higher latitudes (Lewis, J. R. *The Ecology of Rocky Shores* (1964), Hodder & Stoughton). This would certainly seem to imply some climatic limitation. Low sea temperatures may reduce the length of the breeding period, extend its pre-competent larval life (and hence increase dispersal) or cause juvenile mortality. There are even suggestions of a geographical cline in the pattern of spawning of *Monodonta* which, if other factors did not intervene, could well continue to the point at which repopulation would become impossible (Kendall, (1978) *op cit.*).

COMMUNICATIONS

Monodonta is one of a number of organisms whose north-eastern limits reach the coasts of Dorset and the Isle of Wight. Crisp & Southward (1958, *op. cit.*, p. 166) tabulate the main environmental differences between the western and eastern parts of the Channel. They show that winter temperatures of the eastern part are substantially lower with higher incidence of frosts. The general north-south direction of isotherms in summer and the east-west direction in winter are as much a feature of the air conditions as they are of the sea. As air temperatures have a greater range than sea temperatures they may play a greater part in controlling distribution, particularly for an intertidal mollusc that lives as high on the shore as *Monodonta*. The sharpness of the distributional boundary may also have much to do with the closeness of the winter isotherms here but both the sharpness and the limitation on other species suggest that other factors may be operating (Lewis, *op cit.* (1964), p. 243). It nevertheless seems likely that the position of a critical isotherm (perhaps the 5° February isotherm) has shifted westwards causing the elimination of the marginal *Monodonta* populations at the easternmost limit of their range.

I thank Ian Killeen and Dennis Seaward for their helpful comments on this Communication.

R. C. PREECE

Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ

RECENT TURRID RECORDS FROM SOUTHERN ENGLAND

The family Turridae is placed in the superfamily Conacea which includes the temperate turrids and the tropical cones and terebrids. This group of molluscs is also known as the Toxoglossans which possess a radula that is reduced to a series of separate darts which can be charged with poison secreted from a modified salivary gland. As such, turrids are highly specialised predators but little is known of their modes of life. Most are dredged as isolated specimens on soft ground: mud or sand with some gravel though some species of *Raphitoma* are found on rocky shores and stony bottoms. The fusiform shell morphology is streamlined for a burrowing habit and with their particular adaptations to a predatory, carnivorous lifestyle, it is likely that their prey is soft bodied, for example annelids.

Scrutiny of *The Distribution of the Marine Molluscs of North West Europe* (Seaward, D. R. (1990) NCC, Peterborough) reveals a paucity of records for live turrids in southern England, especially east of Portland Bill, Dorset. Recent sublittoral investigations on both Society field meetings and personal dredging trips have yielded a significant number of new and updated records for several species of turrid:

Haedropleura septangularis (Montagu, 1803)

Seaward (1990, *op cit*) gives a scattering of records from the Channel to western Scotland but most of these pre-date 1950. The only recent records are from Lundy (Picton B. E. *Rep. Lundy Fld. Soc.* **29** (1978)); southwest Ireland (S. M. Smith) and western Scotland (Killeen I. J. & Smith S. M. *J. Conch. Lond.* **34** (1992) p. 257). In December 1992 a single specimen was retrieved from a haul of gravel and detritus dredged from a depth of 7m off Shoreham, Sussex (50°49·2'N, 00° 16·2'W) (J. M. Light). The associated molluscs were *Hinia reticulata*, *H. incrassata*, *Gibbula cineraria*, *Crepidula fornicata* and *Mytilus edulis*.

Mangelia attenuata (Montagu, 1803)

This is a western and northern species in British Isles and is said to occur on sandy and clay bottoms from 5–150m (Graham A., 1988. Molluscs: prosobranch & pyramidellid gastropods *Synopses of the British fauna (NS) No. 2*, Leiden). One specimen was found in silty mud dredged from 9m depth south-east of Sandsfoot Castle, Portland Harbour, Dorset (50°35·4'N 02°27·1'W) in June 1992 (I. J. Killeen). The associated fauna was dominated by *Abra alba*, *A. nitida* and *Thyasira flexuosa*. I have recently examined a specimen collected off Overcombe near Weymouth in June 1988. This was originally recorded as *M. attenuata* but has now been re-identified as *M. powisiana* (see below).

Mangelia nebula (Montagu, 1803)

This is generally considered to be one of the commoner turrids in British waters, however, most post-1950 live records are from southwest Britain, southern and western Ireland. During recent and regular dredging activities in Sussex, I have established that it is common in several places between Shoreham and Seaford. It is usually found on bottoms of sand and silty mud at depths of up to 20m. It is a typical component of molluscan faunas that include *Hinia reticulata*, *H. pygmaea*, *Polinices polianus* and *Macra stultorum* and may frequently be found in significant numbers, up to 50 per haul. Its distribution further east is unclear but several hauls on apparently suitable substrates between Camber and Dymchurch have, to date, failed to yield any *M. nebula* (I. J. Killeen *pers. comm.*). To the west, a single specimen was dredged on fine sand, Sandown Bay, Isle of Wight in August 1991 (Light J. M./Killeen I. J.), at a depth of 11m (50°39·5'N 01°08·5'W). This was the first record for the species from the Island. Subsequently it has also been found off Freshwater Bay in August 1992 and the eastern Solent in February 1993. Further west, it is a typical component of the prosobranch fauna in the Weymouth Bay area (see *M. powisiana*).

Mangelia powisiana (Dautzenberg, 1880)

This is a southern species, rare in British waters and only known from southern England (Sea Areas 16–18). A Conchological Society dredging trip to Dorset in June 1992 yielded specimens from a site off Overcombe (50°37.9'N 02°23.5'W) and two further spots in Weymouth Bay (50°37.5'N 02°25.6'W and 50°37.1'N 02°26.2'W). All sites were at depths of 5–8m on a substrate of sand with *Zostera marina* (eel grass). The associated fauna was relatively rich and varied but species such as *Hinia reticulata*, *H. pygmaea*, *Mangelia nebula*, *Nucula nitidosa* and *Pandora inaequalis* were common to all. A specimen was also collected off Overcombe, Dorset (50°37.2'N 02°25.5'W) in June 1988 but originally identified as *M. attenuata*.

M. powisiana has recently been found in hauls dredged off Freshwater Bay, Isle of Wight (50°39.7'N 02°30.2'W) at 11m, in August 1992 (Light J. M./Killeen I. J.). *Zostera* species and *Hinia pygmaea* were absent at this site, otherwise the substrate and molluscan faunas were similar to the Dorset sites. At both the Isle of Wight and Dorset sites, *M. powisiana* was rarer than *M. nebula* in the samples.

Mangelia smithii (Forbes, 1840)

A single live specimen and a fresh shell of this species were taken during a dredging trip of the Conchological Society in Weymouth Bay. Both were collected in June 1988 east of Osmington Mills (50°36.97'N 02°21.43'W) at a depth of 15m. The only other post 1950 records for *M. smithii* are from southwest England and the west coasts of Ireland and Scotland (Seaward, 1990 *op cit*).

Comarmondia gracilis (Montagu, 1803)

A single live specimen was dredged from 30m depth west of Chesil Beach in June 1990 (50°35.5'N 02°31.5'W) and two further live animals were taken in June 1991 off Chesil town, Isle of Portland (50°33.3'N 02°29.5'W) from 40m. Both sites had substrate of gravel and shell with a varied fauna. Notable associated molluscs include *Aequipecten opercularis* and venerids. There have been sporadic records from the western Channel along western coasts to northeast Scotland but few of the recent ones are based on live material.

Raphitoma linearis (Montagu, 1803)

The first living Isle of Wight record has already been published (Light J. M. & Killeen I. J.) *Proc. Isle of Wight nat. Hist. archaeol. Soc.* **9** (1990) pp. 86–90). This was taken off Nab Tower (50°36.5'N 00°53.3'W) in 25m. A second live specimen for the Isle of Wight was collected in August 1992 (Light J. M. & Killeen I. J.) from 16m depth off Culver (50°40.5'N 01°01.5'W). The substrate consisted of cobble and shell gravel with a rich associated fauna including chitons, trochids and *Aequipecten opercularis*. This species occurs around much of the British Isles from LWST to 200m where the animals probably feed on small polychaetes (Graham, 1988 *op cit*).

I am grateful to Dr John Taylor of the Natural History Museum for examining several of the *Mangelia* specimens.

J. M. LIGHT
88 Peperharrow Road
Godalming, Surrey GU7 2PN

REVIEWS

Fauna Iberica, Volume 1, MOLLUSCA: Cephalopoda by Angel Guerra Sierra, 1991 pub. in Spanish by Museo Nacional de Ciencias Naturales Consejo Superior de Investigaciones Cientificas, Madrid. ISBN 84–00–07267–7. Hardback price 2800 Psts. (£15 approx).

The series of Monographs entitled *Fauna Iberica* will enable publication of the results of studies on the biological diversity of the Iberian Peninsula and Balearic Islands. Written by specialists in their individual fields, volumes on vertebrate and invertebrate groups will be produced. If the first volume in the Series is anything to go by, then the publishers have set themselves a very high standard to follow.

The monographs are designed to meet the specification of a sound scientific work and a field guide for the general public and are, as such, aimed at the wide market of professionals, students and amateurs. Dr Angel Sierra is an international authority and has published extensively on cephalopods with leading involvement in several research projects in Marine Biology and Fishery Biology of Cephalopods.

In an introductory section the author identifies the problems of delimiting the marine area associated with the Ibero-Balear peninsula, particularly for the numerous pelagic cephalopod species which are active swimmers. The work that was carried out is summarised and a map of the area under consideration is provided along with a short section on Systematics and general comments on Geographical Distribution. After this there is a comprehensive section on Morphology and Anatomy of adults, which includes characteristics of juveniles and sub-adults, as well as a comprehensive text on all aspects of the natural history of cephalopods. A final useful section deals with collection and preservation.

A list containing 95 species in 33 families and a key to orders and families precedes the main body of the book – some 200 pages giving detailed descriptions. Each species is figured, in many instances a drawing of the whole animal is accompanied by details of arms, tentacles, suckers etc. While some of the illustrations show animals drawn in familiar poses, many of the figures have been drawn specifically for the work; the style is clear and of a very high standard. There are 19 coloured plates at the end including a series of the familiar *Sepia officinalis*.

Throughout, the text is thoroughly referenced and a bibliography contains well over 400 entries. An extensive appendix contains a list giving synonyms for all species dealt with in the book. This is especially useful because cephalopod nomenclature, as with molluscan nomenclature generally, has been the subject of revisionary attention recently at the Cephalopod International Advisory Council in Washington in 1988. A new Superorder Pseudoctobranchia (Guerra, no publicado) and a new Order Idiosepioidea (Boletzky, no publicado) are effectively published by inclusion in the book.

The subject of nomenclature brings me on to the question of the relevance and appeal of this book to a wider European readership, in particular the British one. Looking through the Smith & Heppell Checklist of British Marine Mollusca published in 1990 by the National Museums of Scotland, of the 49 species listed only 5 are missing from the *Fauna Iberica* volume and one of these (*Sepiella japonica*) should be deleted from the British list (Heppell, pers. comm.) Three *Rossia* species on the British list are apparently absent from the area covered by Guerra and there are two instances of disagreement between Guerra and Smith & Heppell over the specific status versus synonymy of one *Illex* and one *Mastigoteuthis* species. This is a higher level of accord than might be expected given the current level of interest in molluscan taxonomy.

I can find very little that has been omitted from this book, although I notice that while sepions (bone) of the cuttle species have been figured, the gladii (pen) of the squids have not. It may be that a reason for this has been mentioned in the text, although I did not find it. This means that the unique gladius of *Vampyroteuthis infernalis* is not shown. Another small complaint involves the use of the word siphon for the hyponome, the latter organ being an enrolment of the muscular mantle and not a siphon in the scientific sense.

As one who is interested in biogeography I would have liked to see some illustrative method employed for the distribution of each species. Although geographical details are given in the text for each species, a small map would have enabled clear presentation of the known geographical ranges.

The publication of this book fills a niche that has been vacant for some time. Perhaps the closest British equivalent we have to the *Fauna Iberica* series is the Linnean Society's *Synopses of the British Fauna* – although this series concerns itself only with invertebrates. While most of the molluscan groups are adequately covered by the *Synopses*, we have badly needed a work on Cephalopods and, in the long run a fresh treatment of Bivalvia. Angel Sierra's contribution fills the former niche very nicely for although it is published in Spanish, so much scientific terminology is homologous across the boundaries of national languages and many of the everyday words are similar to their English equivalents. As a final bonus, the retail price is roughly £15 which for a hardback book of such quality of production and content, is astoundingly good value. It should be obtainable through good bookshops.

JANICE M. LIGHT

Volutes by Guido T. Poppe and Yoshihiro Goto. Published by Mostra Mondiale Malacologia, Via Adriatica Nord 240, 63012 Cupra Marittima (AP-Italy), Italy. ISBN 88-86070-01-2, Price 125,000 Italian Lira (100 U.S.\$)

It is over 20 years since the publication of C. S. Weaver & J. E. du Pont's "The Living Volutes". In that time much new information has been discovered about Volutes and some 100 new species proposed, such as the beautiful *Lyria doutei* and *Amoria ryosukei*. The authors of the present work aimed to provide a summary of current knowledge on Volutes and in this they have largely succeeded.

The bulk of the text consists of a systematic listing of the 247 species considered valid, each with a reference to the original description together with details of range, habitat, dimensions, information on the living animal – 150 radula drawings are included – comments on variation within the species and comparison with similar species highlighting differentiating characteristics. References are given to recent works covering the species with full details given in the bibliography. There is also a distribution map for each species. It is perhaps surprising that the authors include details of world record size specimens, particularly when they do not include any details of values saying that "Shell prices are subject to quick changes and render such a list limited in time" the same is surely true of size records.

The text is accompanied by 107 full colour plates illustrating 750+ specimens, including many type specimens. The quality of the plates is outstanding, although a few copied from other books (particularly Weaver & du Pont) where specimens were unavailable for illustration, have lost some clarity when compared with the originals. I would have preferred some indication of scale with the plates, and it would have been useful to indicate locality data for the specimens illustrated. A few species are only illustrated in black and white in the text although these are mainly rare/deep water species. It is perhaps surprising though that *Scaphella evelina* which is only illustrated in black and white carries no reference to Abbott & Dance's *Compendium of Seashells* where the holotype is illustrated in colour although the *Compendium* is listed in the bibliography and another illustration has been copied from that work.

The book contains comparisons of several recent systematic arrangements of the Volutidae together with a more detailed account of the systematics followed by the authors. Others are better qualified than I to comment on the taxonomy used, however I would query the authors' use of the genus *Athleta* for the group of shells generally referred to as *Volutocorbis*. The authors acknowledge that this point is subject to debate and use *Athleta* "for reasons of simplicity and as the older name", however I would have preferred, for the sake of taxonomic stability, the use of *Volutocorbis* which is in more general use until the matter is resolved.

A few statements are made without supporting evidence/references, for example, referring to *Cymbiola novosa* "the use of the names 'oblita' and 'norrisi' are due to misinterpreting and confusion with other species". *Oblita* is so well established in the literature that I would have preferred some support for this sweeping statement. Having said that there is much that has become clearer from a study of this book. The coverage of the *Lyria planicostata* complex is the best I have seen and the key to identification in the genus *Melo* is very useful.

There are a few minor printing errors in the text: p. 28 *Guivillea alabastrina* Watson, 1822 should be 1882. Hicson Cay should be Hixson Cay (p. 208). A reference to *Nanomelon vossit* should be to *N. vossi* (p. 119). The 'V shaped channel' which distinguishes *Cymbium olla* should be 'U shaped channel' (p. 181), but these are minor and considering the length and complexity of the text, few in number. There are a couple of places where the text is less clear than might have been possible, for example the sentence "Are considered 'rare' in shells all specimens (sic) of which only a few examples exist in collections" but these are probably due to the international nature of the book – Belgian and Japanese authors, Italian Publisher and English text! This presumably also explains the use of 'anos' for anon throughout the text. More noticeable errors occur in the maps where for example *Lyria delessertiana* is shown with a range of S.W. Madagascar (the text correctly gives Northern Madagascar as locality). Likewise the map for *Fulgoraria hamillei* bears no relationship to the distribution given (correctly) in the text.

The main 'errors' though are errors of omission rather than commission and here, whilst the bibliography shows that the authors have extensively surveyed recent specialist literature, there is much in more general books which has escaped their attention. For example, the authors interestingly mention those species where sinistral specimens are known, yet they make no mention of the sinistral *Cymbium cucumis* formerly in the collection of A. P. H. Oliver and illustrated in his *Hamlyn Guide to Shells of the World* and also in S. P. Dance's *Shell Collectors Guide*, this is probably the most widely known specimen of a sinistral Volute in existence! Likewise the authors state of *Fulgoraria megaspira* "The exact range is unknown. Probably a Japanese species". Yet Matsukama, Okutana and Habe illustrate a specimen in *World Seashells of Rarity and Beauty* with the exact locality – Sagami Bay, Japan. Similarly for *Lyria cordis* the account does include a description of the animal, but does not refer to the stunning photograph of the living holotype in R. T. Abbott's *Kingdom of the Seashell*. This photograph also clearly shows the species to possess an operculum, a fact the authors do not mention.

I would have personally preferred more information on the living Volutes, particularly some of the stunning photographs of living animals which have become available in recent years. The authors do give references to these and in many cases give descriptions, but as they themselves say speaking about the shell "drawings or pictures speak louder than words and provide more information than a lengthy text". Instead of collecting this information and these pictures together they remain scattered through the literature.

This book is mainly aimed at collectors of Volutes, but has wider scientific use in providing a summation of post

REVIEWS

Weaver and du Pont information. This book cannot be used as a replacement for Weaver and du Pont – the bibliography is restricted to major works and those published after Weaver and du Pont and the synonymies are restricted to names published after Weaver and du Pont or where new information has caused changes to be made – but it serves as a companion to that work as the authors intended. Highly recommended and essential to anyone specialising in this family.

K. J. T. BROWN

Thomas Berthold: *Vergleichende Anatomie, Phylogenie und Historische Biogeographie der Ampullariidae (Mollusca, Gastropoda)*. Abhandlungen des Naturwissenschaftlichen Vereins in Hamburg, NF **29**: 1–256. Hamburg (Parey) 1991. ISBN 3–490–15196–8. DM 98 Paperback.

The author characterizes the species of the freshwater prosobranch family Ampullariidae on a conchological basis (6½ pp. + 4 photographic plates) and describes the anatomy of 36 species (104 pp.). He distinguishes ten genera, for which he gives the classic shell characters (i.e. without ultrastructure descriptions). The anatomical description of the available species from the six genera *Afropomus*, *Saulea*, *Lanistes*, *Pila*, *Marisa*, and *Pomacea* comprises the external morphology (4 pp.), the topography and histology of pallial organs (9 pp.), the circulatory and excretory system (10½ pp.), the reproductive system (43 pp.), the digestive tract (20 pp.), and the nervous system (14 pp.). In addition, functions, as reproductive activities and locomotion, are included.

Before starting a phylogenetic reconstruction the author expresses his views about the pre-conditions of analytical procedure, and so increases the value of the book by including this exemplary introduction into the theory of phylogenetic systematics *sensu* Willi Hennig. It is the crucial process of character state weighting that requires a decision, in each case, for the direction of character state transformation. Berthold discusses (10 pp.) the approaches adopted by various schools. The extremes would argue *either* purely on outgroup comparison (the – European – cladists' view), *or* would place considerable emphasis on the question of the adaptive value of character states (the form/function or “economy principle” school of Gutmann [W. F. GUTMANN, 1989, *Senckenberg-Buch* **65**: 201 pp., Frankfurt]). After a critical analysis of the various procedures used in the literature, Berthold adopts a moderate approach, replacing the economy principle by a fitness principle, “which permits the establishment of correlations between adaptational processes and relative fitness as a means of character evaluation” (pp. 3). He gives good reasons for combining outgroup comparison with adaptational processes, because it “allows differentiation between cladogenetic and anagenetic aspects in reconstruction of the phylogeny” (p. 3). For any taxonomist, even a beginner, who has command of the German language, these chapters are profitable reading matter. This holds also for his step by step weighting of hypotheses based on increasing sets of characters. The reader is able to follow intermediate arguments through many of the trees, which virtually makes this book a textbook of phylogenetic systematics. This is also true for the part dealing with biogeography. It is more detailed than a publication in a journal usually could afford. It bears, however, the great chance – not only for the author to show, but also for the reader to learn – which facts (the historical portion) and factors (the ecological portion) should be considered before hypothetical conclusions based on morphology and distribution can be drawn. The author presents seven scenarios as possible sequences of splitting events. On the present knowledge of Recent and fossil distribution, he favours a scenario suggesting an origin of the family in South Africa and the Malagassic region, with an offshoot to southern South America (i.e. the first stem species of Antlipneumata, which is a newly introduced taxon for the group comprising *Pila* and all South American taxa, the “Spiropeniata”), some 140 Million years ago. This scenario requires only two additional presumptions, among others a slight delay in separation of the Indo-Malagassic plate from Africa, until after the opening of the South Atlantic.

The book contains extraordinarily few errors: some in lettering (K with different meanings in various figures: Kiel (keel), Kieme (gill), or Kiefer (jaw)); the claim that, among the Bithyniidae, only *B. tentaculata* possesses a calcified operculum (p. 140), or that *Marisa cornuarietis* is a potential host of *Schistosoma bovis* (p. 231).

An Appendix (4 pp.) deals with the nomenclature of supra-specific taxa. The family name Ampullariidae is used in the title, despite the fact that the generic name *Ampullaria* Lamarck, 1799 is a junior synonym of *Pila* Röding, 1798. This is defended on the grounds of non-use, by the majority of authors, of the alternative family name Pilidae.

The book is recommended also to investigators of other groups, as it forms a conveniently up-to-date review of general anatomy and functional morphology of prosobranch gastropods. The high printing quality and good reproduction standard of photographs is especially appreciated.

CLAUS MEIER-BROOK, Inst. Trop. Med., Univ. of Tübingen

INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr R. C. Preece, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ.**

PAPERS Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

Journal of Conchology

Vol. 34, Part 5, June 1993

Contents

	PAGE
PAPERS	
H. C. G. CHESNEY, P. G. OLIVER and G. M. DAVIS— <i>Margaritifera durrovensis</i> Phillips, 1928: Taxonomic Status, Ecology and Conservation	267
J. LUCEY—The distribution of <i>Margaritifera margaritifera</i> (L.) in Southern Irish Rivers and Streams	301
M. B. SEDDON, D. T. HOLYOAK and P. TATTERSFIELD—Taxonomy, Ecology and Distrubution of <i>Leiostyla</i> in W. Europe and NW. Africa (Gastropoda: Pupillidae)	311
M. B. SEDDON AND D. T. HOLYOAK—Land Gastropoda of NW. Africa: New Distributional Data and Nomenclature	321
B. VERDCOURT—The Identity of <i>Tropidophora hanningtoni</i> (Sowerby III) (Gastropoda: Pomatiasidae)	333
OBITUARY	
VERA FRETTER (1905–1992)	337
COMMUNICATIONS	
INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE	339
R. C. PREECE— <i>Monodonta lineata</i> (da Costa) from Archaeological Sites in Dorset and the Isle of Wight	339
J. M. LIGHT—Recent Turrid Records from Southern England	341
REVIEWS	343

Journal of Conchology

4, Part 6

ISSN 0022-0019

January 1994



LIBRARY
FEB 20 1994
LIBRARY

**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN
AND IRELAND**

51 Wychwood Avenue, Luton, Bedfordshire LU2 7HT

Hon. Secretary: Mrs S. DAVIES,
5, The Deans, Portishead, Bristol BS20 8BG

Hon. Treasurer: Mr. A. SECCOMBE,
26 Courtland Avenue, Ilford, Essex IG1 3DW

Hon. Editor: Dr. R. C. PREECE,
Department of Zoology, University of Cambridge,
Downing Street, Cambridge CB2 3EJ.

Member's subscription: £21 per annum. **Entrance fee:** £1.

Family membership: £23 per annum.

Institutional membership: £30 per annum.

Students membership: £10

Meetings are held at the British Museum (Natural History) at 2.30 p.m. usually on the third Saturday of each month from October to May. Field Meetings are held in the summer.

Publications: Members receive

The Journal of Conchology (usually two numbers a year).

The Conchologists' Newsletter (quarterly).

For back-numbers of these publications and special numbers please apply to Mr A. Norris, Leeds City Museum, Municipal Buildings, Leeds LS1 3AA.

Programme Secretary: Mr. I. J. KILLEEN, 163 High Road West, Felixstowe, Suffolk IP11 9BD.

Marine Census Recorder: Mrs. J. LIGHT, 88 Peperharow Road, Godalming, Guildford, Surrey GU7 2PN.

Non-marine Census Recorder: Dr. M. P. KERNEY, Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD.

Newsletter Editor: Mr. P. LEE, Rochdale Cottage, Camps Heath, Lowestoft, Suffolk NR32 5DW.

COVER DESIGN: *Muricanthus nigritus* (Phillippi) by D. G. Reid.

NOTICE

Payment by Overseas Members

Overseas members are reminded that all monies due to the Society are payable in sterling.

© Conchological Society of Great Britain and Ireland
PHOTOSET BY WILMASET LIMITED, BIRKENHEAD, MERSEYSIDE
PRINTED BY EATON PRESS LIMITED, WALLASEY, MERSEYSIDE

ON THE IDENTITY OF *PLEUROTOMA*
(*DEFRANCIA*?) *PIPERATA* E. A. SMITH, 1882, A
WEST AMERICAN COLUMBELLID DESCRIBED
FROM KOREA (GASTROPODA:
COLUMBELLIDAE)

R. N. KILBURN¹

(Accepted for publication, 16th October, 1993)

Abstract: Comparison of syntypes of the gastropod *Pleurotoma* (*Defrancia*?) *piperata* E. A. Smith, 1882, with the holotype of the West American *Mangelia* (*Steironepion*) *melanosticta* Pilsbry & Lowe, 1932, shows them to be conspecific. The type locality for *P. piperata*, erroneously given as the “Straits of Korea”, is corrected to Mazatlán, West Mexico, and the species transferred to the genus *Nassarina* Dall, 1889, subgenus *Steironepion* Pilsbry & Lowe, 1932, in the family Columbellidae.

Key words: *Pleurotoma*, *Nassarina*, Mazatlán, West Mexico, Straits of Korea

INTRODUCTION

Between 1882 and 1888, E. A. Smith published a series of papers devoted to the description of a large number of new species of Turridae. None of these were accompanied by figures, and as a consequence the majority have remained unrecognized to this day. Recognition of many taxa is further hampered by the inaccuracy of given locality data, or by its total absence. Their labels show, for example, that Hugh Cuming’s collection, known to sometimes contain erroneous data, provided types for many of Smith’s new species. The material in question was presumably acquired by Cuming subsequent to publication of Reeve’s monographs on *Mangelia* and *Pleurotoma* in 1843–1846. Many of the other types appear to have been purchased from dealers such as G. B. Sowerby and R. F. Geale, and, as is not infrequent in such cases, this locality information is often unreliable. In the course of examining and photographing the types of Indo-Pacific Turridae, I have scrutinized most of Smith’s type material of the family preserved in the Natural History Museum, London. Amongst this was the syntype series of *Pleurotoma* (*Defrancia*?) *piperata*, a species described by Smith from the “Straits of Korea”. The types were immediately recognizable as the tropical West American *Nassarina* (*Steironepion*) *melanosticta* (Pilsbry & Lowe, 1932), a conclusion subsequently confirmed by direct comparison with the holotype of that taxon. *Steironepion* Pilsbry & Lowe, 1932, of which *Mangelia melanosticta* is the type species by original designation, was transferred by Keen (1971) to the family Columbellidae as a subgenus of *Nassarina* Dall, 1889; Radwin (1977) treated *Steironepion* as a full genus within that family.

The specimens on which *P. piperata* was based, originated from the Cuming collection. The original description claimed (perhaps wrongly) that they were obtained from Arthur Adams, who did in fact collect molluscs in the Straits of Korea during the voyage of *H. M. S.*

¹ Natal Museum, Private Bag 9070, Pietermaritzburg 3200, South Africa.

Samarang. Their true origin will never be known, but a possibility would be the Reigen collection from Mazatlán, Mexico, part of which was sold in Britain in about 1850 (Dance 1986: 148). This falls within the known range of the species (Keen 1971), and is here designated as the corrected type locality for *Pleurotoma piperata*.

Family Columbellidae

Nassarina (Steironepion) piperata (E. A. Smith, 1882)

Figs 1–4

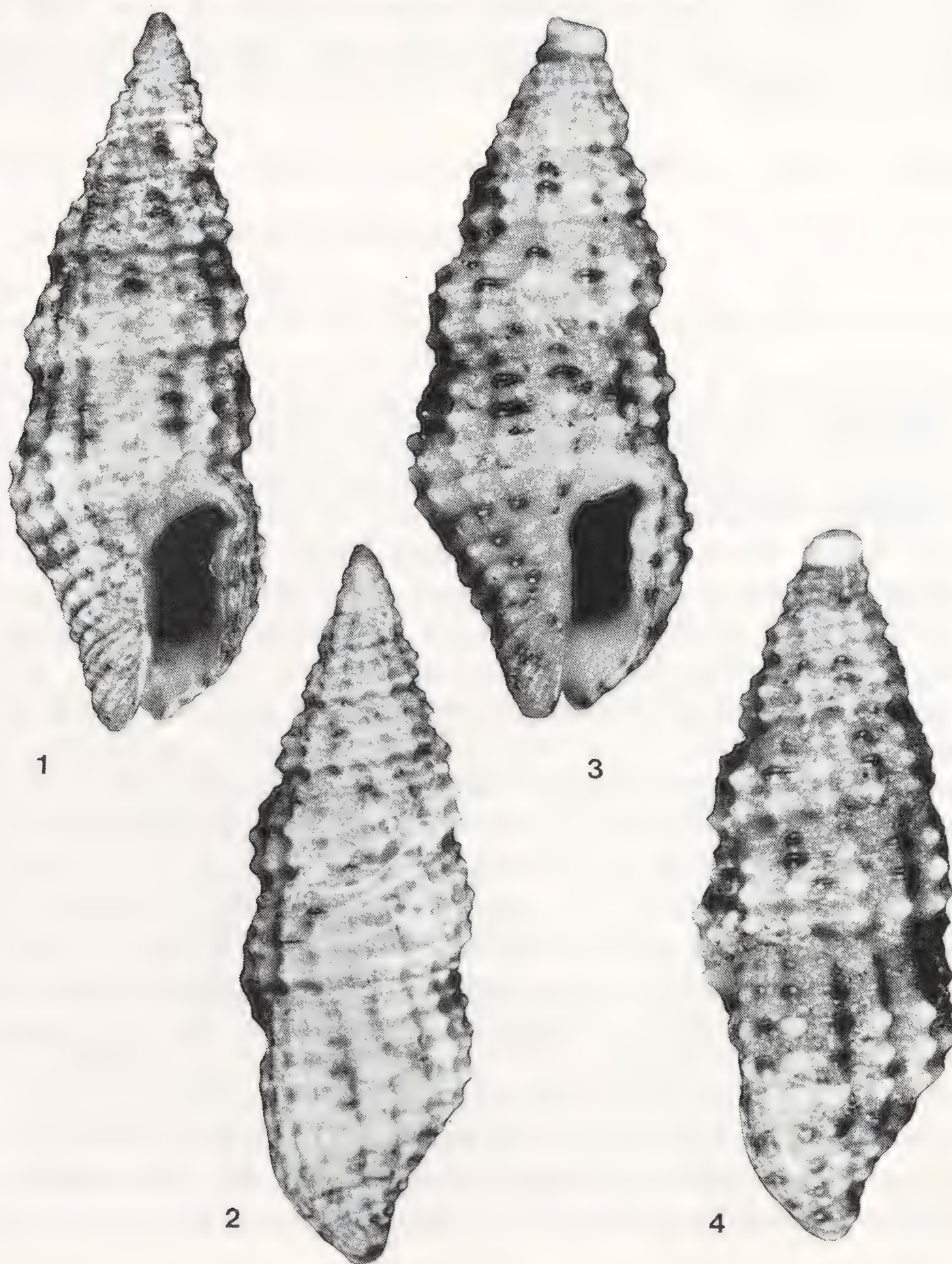
Pleurotoma (Defrancia?) piperata E. A. Smith, 1882: 298. Type locality: "Straits of Korea" [here corrected to Mazatlán, Mexico].

Lienardia piperata; Kuroda & Habe, 1952: 63.

Mangelia (Steironepion) melanosticta Pilsbry & Lowe, 1932: 56, pl. 3, fig. 9, text fig. 3. Type locality: San Juan del Sur, Nicaragua.

Nassarina (Steironepion) melanosticta; Keen, 1971: 595, fig. 1251.

Type material: *Pleurotoma (Defrancia?) piperata*: 5 syntypes, Natural History Museum, London, 1966463, H. Cuming collection, *ex* A. Adams; one specimen, measuring 4.9×1.8



Figs. 1–4. *Nassarina piperata* (E. A. Smith). Figs. 1–2 Lectotype; Figs 3–4 Holotype of '*Mangelia melanosticta*'

mm, is here designated as lectotype (Figs. 1–2). *Mangelia* (*Steironepion*) *melanosticta*: holotype (Figs. 3–4), Academy of Natural Sciences of Philadelphia 155192, ex H. N. Lowe, 1931.

Notes: Although the holotype of *M. melanosticta* retains only the base of the protoconch, this was illustrated by Pilsbry & Lowe (1932: text fig. 3) from another specimen. An identical protoconch is retained in several of the syntypes of *P. piperata*. This serves to distinguish the latter from the otherwise similar western Atlantic *Nassarina* (*Steironepion*) *monilifera* (Sowerby, 1844), in which Radwin (1977: 131) noted the presence of a very different protoconch.

Although listed (as *Lienardia piperata*) by Kuroda & Habe (1952), this record was presumably based on the erroneous type locality, and I can find no further trace of the name anywhere in the literature subsequent to its description.

ACKNOWLEDGEMENTS

For the loan of type material, I am indebted to Ms. Kathie Way of the Natural History Museum, London, and Dr. Gary Rosenberg of the Academy of Natural Sciences of Philadelphia. Drs. D. G. Herbert and J. G. H. Londt kindly commented on the manuscript.

REFERENCES

- DANCE, S. P. 1986. *A history of shell collecting*. Brill-Backhuys, Leiden. pp 265, pls. 32.
- KEEN, A. M. 1971. *Sea Shells of Tropical West America*. Stanford University Press, Stanford, California. pp. 1064.
- KURODA, T. & HABE, T. 1952. *Check list and bibliography of the Recent marine Mollusca of Japan*. Tokyo: Stach. pp. 210.
- PILSBRY, H. A. & LOWE, H. N. 1932. West Mexican and Central American mollusks collected by H. N. Lowe, 1929–31. *Proc. Acad. nat. Sci. Philadelphia* **84**: 33–144, pls. 1–17.
- RADWIN, G. E. 1977. The family Columbelloidea in the Western Atlantic. Part IIa – The Pyreninae. *Veliger* **20**(2): 119–133.
- REEVE, L. A. 1843–46. Monograph of the genus *Pleurotoma*. *Conchologia Iconica*. Reeve, London. **1**: 1–369.
- , 1846. Monograph of the genus *Mangelia*. *Conchologia Iconica*. Reeve, London. **3**: 1–8.
- SMITH, E. A. 1882. Diagnoses of new species of Pleurotomidae in the British Museum. *Ann. Mag. nat. Hist.* [5] **10**: 206–218, 296–306.

NEW DISTRIBUTIONAL DATA FOR
RUPESTRELLA DUPOTETII (TERVER)
(GASTROPODA: CHONDRINIDAE) FROM
SOUTHERN SPAIN AND NW. AFRICA, WITH
NOTES ON ALLEGEDLY SUBSPECIFIC
CHARACTERS

J. R. ARRÉBOLA BURGOS¹ AND E. GITTENBERGER²

(Accepted for publication, 16th October, 1993)

Abstract: The range of *Rupestrella dupotetii*, hitherto known from NW. Africa, is extended to S. Spain. Further records are given from NW. Africa, showing that not all the populations can be classified unequivocally with one of the two subspecies distinguished in the literature.

Key words: Gastropoda, Chondrinidae, *Rupestrella*, Spain, NW. Africa, subspecies.

INTRODUCTION

Recent work in the Spanish provinces of Sevilla (JRAB) and Malaga (Mr. J. S. Torres Alba) revealed the presence of a problematic species of the subfamily Chondrininae at two sites. These were found to be the first records of *Rupestrella dupotetii* (Terver, 1839) outside of N. Africa. This short paper describes these new records, as well as presenting new distribution data for NW. Africa.

R. dupotetii is usually found on limestone rocks, often together with species of *Chondrina*, and as such it can easily be overlooked due to misidentification as juvenile *Chondrina*. When the shells are covered with mud, this error is even more likely to occur.

Holyoak & Seddon (1986) reported new populations of *R. dupotetii* from N. Morocco and NW. Algeria, and divided these into two subspecies on the basis of shell dimensions, especially width. However, not all the newly discovered populations studied in the present paper fit well into that scheme.

The material studied is listed below. It is now in the following collections: Arr, J. R. Arrébola Burgos (Sevilla); Men, H. P. M. G. Menkhorst (Krimpen aan de IJssel); NNM, Nationaal Natuurhistorisch Museum (Leiden).

Rupestrella dupotetii (Terver, 1839)

Vertigo dupotetii Terver, 1839: 32, pl. 4, f. 12, 13 (“à Bougie sur le chemin qui conduit de la Casbah à la marine”, “entre le Blockaus de Kalifa et le fort Clausel, sur les rochers au dessus du marabout de Si-Aya-Bosgri, près du fort Bonack, etc.”).

¹ University, Fac. Biologia–Zoologia, Avda. Reina Mercedes 6, E 41012 Sevilla, Spain

² Nationaal Natuurhistorisch Museum, P.O. Box 9517, NL 2300 RA Leiden, The Netherlands. (Corresponding author).

Granopupa dupoteti [sic]; Pilsbry, 1918: 349, pl. 47, f. 7, 8.

Rupestrella dupotetii sebouensis Holyoak & Seddon, 1986: 186 ("above gorge of Oued Sebou, c. 6 km W. of El Menzel, Moyen Atlas, Morocco").

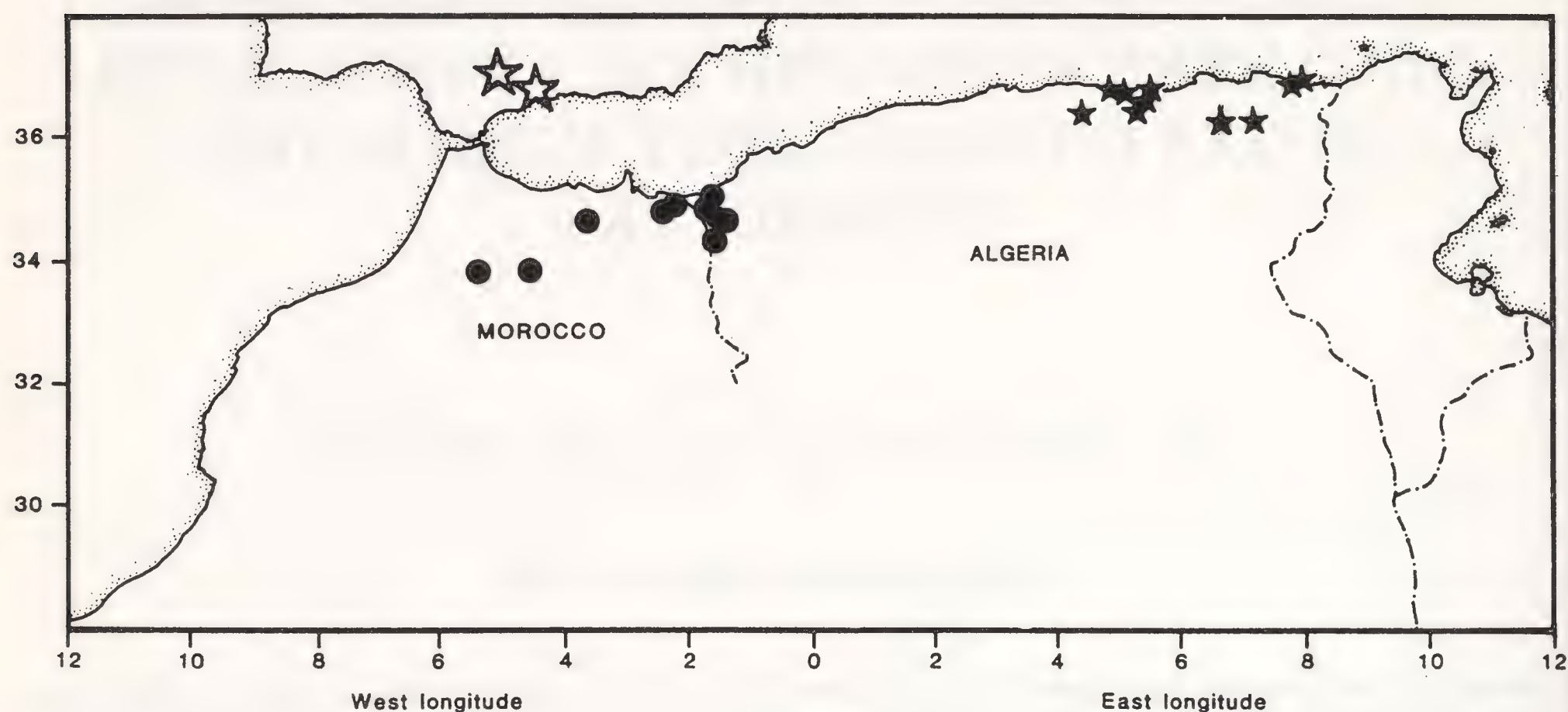


Fig. 1. Records of *Rupestrella dupotetii*, after Holyoak & Seddon (1986: 189, Fig. 3) and new data. The range is subdivided into [1] E. Algeria (stars), [2] W. Algeria & Morocco (dots), and [3] S. Spain (open stars). *R. d. dupotetii* was reported from subrange [1], and *R. d. sebouensis* from subrange [2]. See the text.

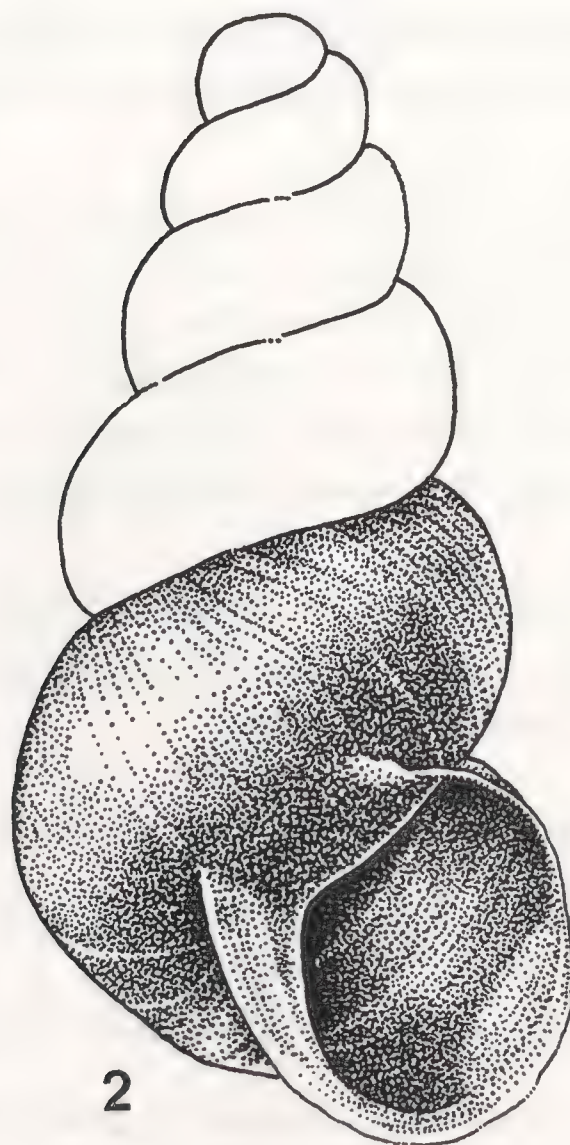


Fig. 2. *Rupestrella dupotetii*; Spain, Sevilla, Pruna; actual height 3.5 mm. E. J. Bosch del.

Material examined

Additional to the data summarized by Holyoak & Seddon (1986: fig. 3), the following records (with UTM 10 or 1 km codes) can be given. Following the abbreviation indicating the collection where the material is kept, the number of specimens in the sample is indicated.

Algeria: Tlemcen: 4 km SSW. of Honaine (= 18 km ENE. of Ghazaouet) along the road W103a, 700 m alt., XD29 (A. J. de Winter leg.) [NNM/79]; 3 km SW. of Khemis (= 38 km SW. of Tlemcen), 1050 m alt., XD33 (A. J. de Winter leg.) [NNM/32]; 1.5 km N. of the Cascades d'El-Ourit (=3.5 km E. of Tlemcen), XD56 (A. J. de Winter leg.) [NNM/1].

Morocco: Meknès: slope along the road S306 near Volubilis, 2 km NW. of Moulay-Idriss, TC67 (H. P. M. G. Menkhorst & Th. E. J. Ripken leg.) [Men/10]. Nador: "Kerker", or (?) Djebel Kech-Kech, 16 km W. of Midar, VD36 (Rutlant leg., ex colln C. Altimira) [NNM/17].

Spain: Sevilla: Pruna, UF09 (J. R. Arrébola Burgos leg.) [Arr/22 & NNM/4]. Málaga: S. Cerro San Antón, El Palo, 400 m alt., UF7867 (J. S. Torres Alba leg.) [NNM/17].

Range: The material examined provides new distributional data extending the known range of *R. dupotetii* to other sites in Morocco and two sites in S. Spain (Fig. 1).

Shell characters

The shell (Fig. 2) is slender conical, with very convex whorls, covered with an irregular, (very) coarse radial sculpture. There are no apertural teeth. Live specimens of *R. dupotetii* can easily be confused with juvenile *Chondrina* sp., because their shells are often covered with mud. However, specimens of the former species can be separated easily when clean, by the much taller initial whorls (compare Figs 2 and 3, upper whorls).

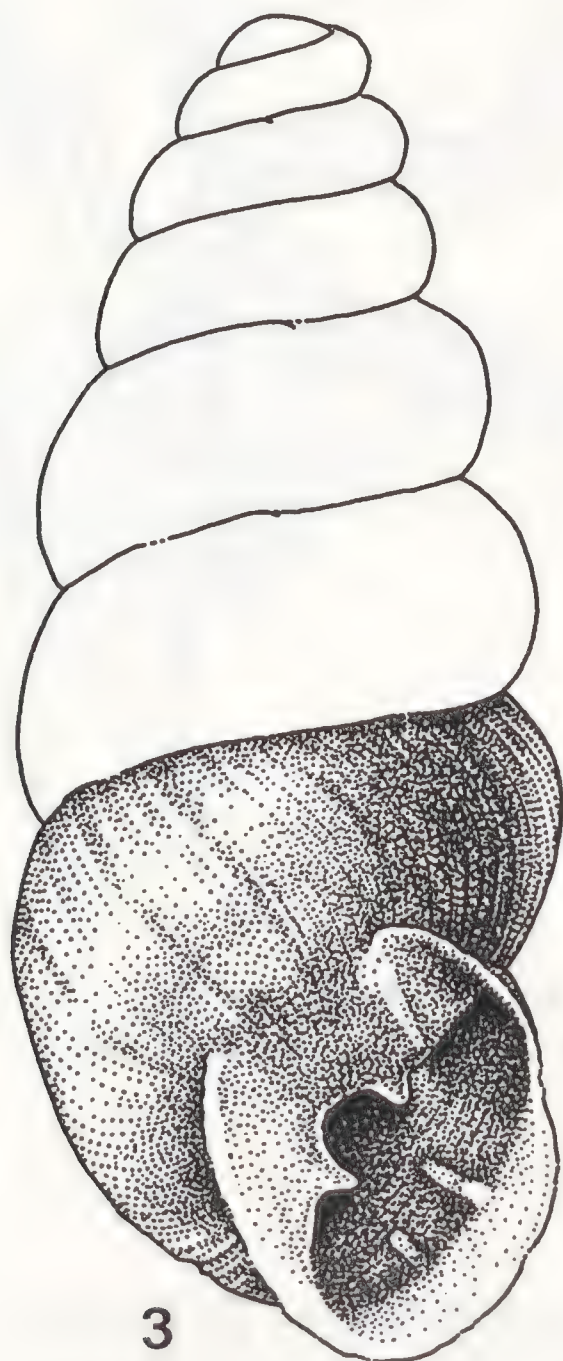


Fig. 3. *Chondrina farinesii granatensis* (Alonso, 1974); Spain, Granada, Cueva del Agua; actual height 5.5 mm. E. J. Bosch del.

Table 1. Measurements of *R. dupotetii*

	Site UTM Code	No. of Shells	Height Range (mm)	Breadth Range (mm)
Algeria	XD29	79	3.1 –3.7	1.8 –2.0
	XD33	32	3.0 –3.8	1.75–2.0
	XD56	1	3.35	1.95
Morocco	TC67	10	3.3 –3.5	2.0 –2.1
	VD36	17	3.25–3.6	1.85–2.25
Spain	UF09	26	3.0 –4.0	1.7 –2.2
	UF7867	17	3.1 –3.6	1.8 –2.15

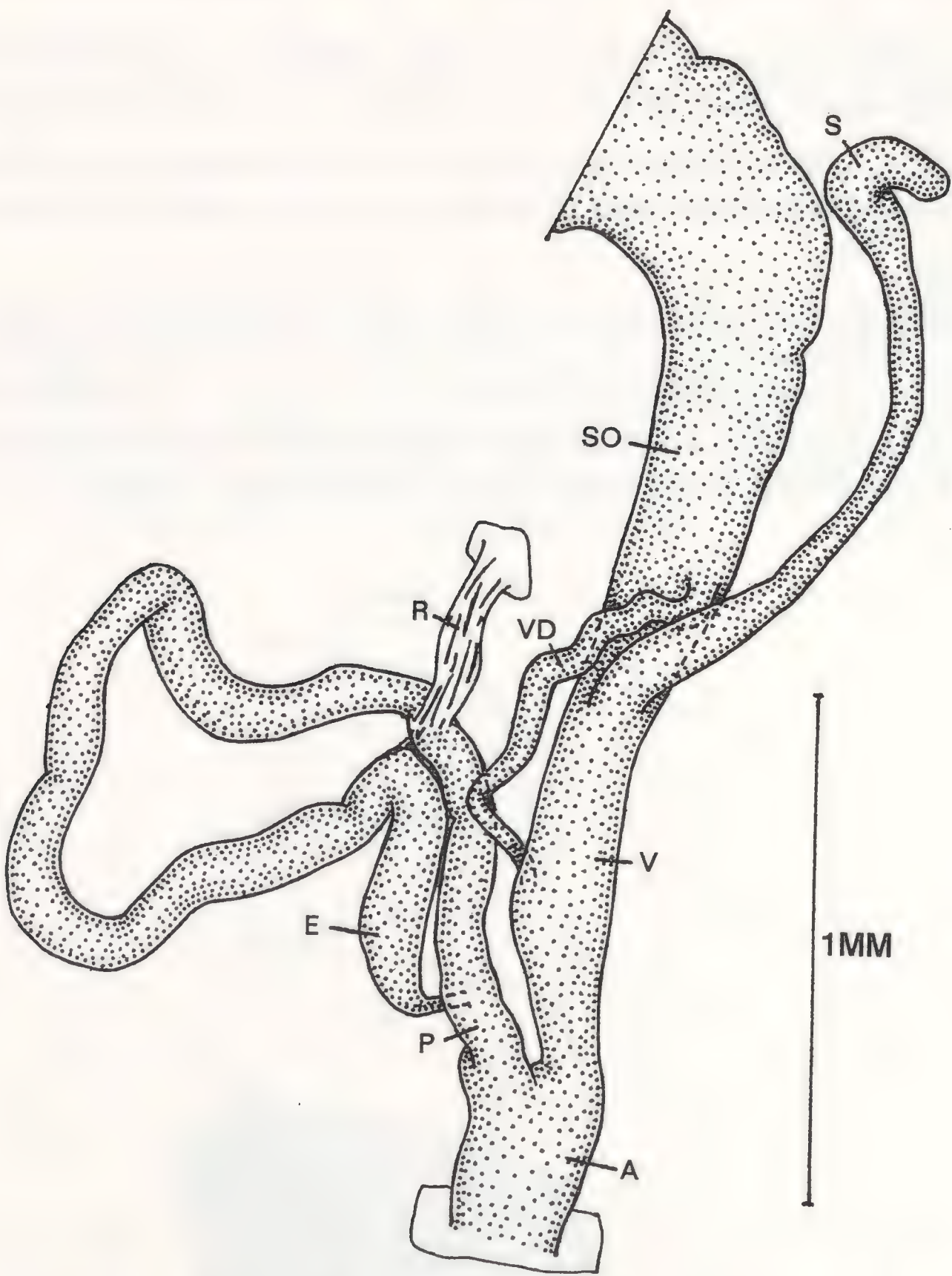


Fig. 4. *Rupestrella dupotetii*, proximal genitalia; Spain, Sevilla, Pruna. Abbreviations: A, genital atrium; E, epiphallus; P, penis; R, penial retractor muscle; S, spermatheca; SO, spermoviductus; V, vagina; VD, vas deferens.

Genitalia

One specimen from the Spanish population at Pruna was dissected (Fig. 4). Its genitalia proved to be most similar to those of a specimen figured as *R. d. dupotetii* by Holyoak & Seddon (1986: 188, fig. A). This is due to the relatively broad male ducts. However, given the few specimens studied anatomically this might be individual variation only.

DISCUSSION

The subspecies

According to Holyoak & Seddon (1986: 186, 188, table 1) two subspecies can be distinguished on shell characters within *R. dupotetii*. Shell width was considered the principal difference. For *R. d. dupotetii* and *R. d. sebouensis* the following heights and widths were indicated: $3.2-4.0 \times 2.0-2.3$ mm and $2.9-3.7 \times 1.5-2.0$ mm, respectively. Thus a shell width of over or below 2.0 mm was considered diagnostic for subspecific separation.

A 2.0 mm borderline is not evident in the newly reported material (table 1). The new N. African samples reported in this paper are within the distributional range of *R. d. sebouensis*, but only the W. Algerian specimens are less than 2.0 mm broad and conform to the reported pattern. Conversely, one sample from Morocco is over 2.0 mm in breadth, whereas in the second sample the shell width is intermediate (1.85–2.25 mm). The Spanish shells have dimensions which bridge the limits between the subspecies *sensu* Holyoak & Seddon (1986); the specimens from Pruna are relatively slender, and in absolute measurements higher but not broader than the ones from El Palo.

On the basis of the new data, we cannot follow the subspecific classification of *R. dupotetii*, especially not for the Spanish populations of this species.

ACKNOWLEDGEMENTS

We wish to thank Ir. H. P. M. G. Menkhorst, Mr. Th. E. J. Ripken and Mr. J. S. Torres Alba, who most kindly provided us with data from their molluscan collections.

REFERENCES

- HOLYOAK, D. T. & SEDDON, M. B. 1986. Geographical variation in *Rupestrella dupotetii* (Terver) (Gastropoda: Chondrinidae) from Morocco and Algeria. *J. Conch., Lond.* **32**: 185–190.
- PILSBRY, H. A., 1918. *Manual of Conchology*. 2nd ser., Pulmonata. vol. XXIV Pupillidae (Gastrocoptinae), part 96, pp. 257–380, pls. 39–49. Acad. Nat. Sci., Philadelphia.
- TERVER, A.-P., 1839. *Catalogue des mollusques terrestres et fluviatiles, observés dans les possessions Françaises au Nord de l'Afrique*. Baillière, Paris & Lyon, 40 pp., 4 pls.

FURTHER NOTES ON THE ACICULIDAE (GASTROPODA: PROSOBRANCHIA) OF NW. AFRICA¹

D. T. HOLYOAK² AND M. B. SEDDON³

(Accepted for publication, 16th October, 1993)

Abstract: Additional data are presented on the distribution and ecology of the Aciculidae in NW. Africa. *Platyla polita* has not been recorded before in NW. Africa, and this record extends its range south from Spain. The first record is given of *Acicula lallemanti* in Morocco and additional records of *Acicula algerensis* in Morocco are also given.

Key words: Aciculidae, *Acicula lallemanti*, *Acicula algerensis*, *Platyla polita*, Distribution, Habitats, Morocco, Algeria.

INTRODUCTION

The prosobranch land snails of the family Aciculidae are widespread in the Western Palaearctic region. This family was the subject of a monograph by Boeters, Gittenberger & Subai (1989), which provided many descriptions of new species as well as distributional data. The species in NW. Africa were part of an earlier review by Gittenberger & Boeters (1977) who examined the status of the species described by Bourguignat (1864) in *Malacologie d'Algérie*. In this work Bourguignat described three species of Aciculidae from Algeria; two of these are now placed in the genus *Acicula* (*A. lallemanti* and *A. benoiti*) and one species in the genus *Renea* (*R. letourneuxi*). Gittenberger & Boeters (1977) recognized that museum material of *A. lallemanti* represented two species and described a new species, *A. algerensis*. Consequently all records published before 1977 refer to *A. lallemanti* or *A. algerensis*. Boeters *et al.* (1989) examined material held in museum collections using this as a basis to revise the known distribution of each species. In a recent survey of the species of land Mollusca of Morocco and Algeria new records of several species of *Acicula* were obtained. This paper provides these additional data and comments on the habitats of these species. The specimens are all from the Holyoak-Seddon and Melvill-Tomlin Collections in the National Museum of Wales (NMW). The Holyoak-Seddon Collection has a reference number for each locality (in bold) and a number for each specimen (HS#).

Acicula lallemanti (Bourguignat, 1864)
(Fig. 1 A-D)

Material examined

Melvill-Tomlin Collection, National Museum of Wales (NMW 1955.158): Forêt à Bouberaki, Algeria. 8 shells. Gorge at Blidah, Algeria: Collector Ponsonby. 2 shells.

Holyoak-Seddon Collection, National Museum of Wales

¹ Systematics and Biogeography of the Land-Mollusca of NW. Africa; Contribution no. 8.

² Forwarding address c/o 22 Elm Grove, Watford, Herts., U.K.

³ Address for correspondence; Department of Zoology, National Museum of Wales, Cathays Park, Cardiff, CF1 3NP U.K.



Fig. 1. Scanning electron micrographs of *Acicula* shells from NW. Africa and Gibraltar.

A-D. *A. lallemanti*. A. Algeria NMW.Z.1993.051.30 B. Algeria NMW.Z.1993.051.31 C. Algeria NMW.Z.1993.051.32 D. Morocco NMW.Z.1993.051.33

E-F. *A. algerensis*. E. Morocco NMW.Z.1993.051.34 F. Morocco NMW.Z.1993.051.35

G. *A. norrisi*. G. Gibraltar NMW.Z.1992.014.01

H. *Platyla polita*. H. Morocco NMW.Z.1993.051.36

Scale Bar 0.5 mm

Shells from river floodline debris:

230. 12 August 84, 36°38'N, 3°54'E by N25 c. 11 km SSW of Draa Ben Khedda (SW. of Tizi-Ouzou), Algeria 160 m ASL (above sea level), HS# 1984.336.1.

233. 12 August 84, 36°36'N, 3°35'E Gorges de Beni-Amrane by N5 6 km NW of Lakhdaria (SE of Algiers), Algeria 130 m ASL, HS# 1984.339.1.

297. 27 June 86, 35°34'N, 5°19'W floodline debris of Oued Martin, by S608 5.5 km along road E of Tetouan, Morocco 5 m ASL, HS# 1986.69.4

Fresh shells:

166. 3 August 84, 37°01'N, 7°27'E by W16 c. 12 km SE of Chetaibi, Algeria 210 m ASL, HS #1984.271.1.

232. 12 August 84, 36°36'N, 3°35'E Gorges de Beni-Amrane by N5 6 km NW of Lakhdaria (SE of Algiers), Algeria 130 m ASL, HS# 1984.338.2.

Shells of uncertain age:

223. 11 August 84, 36°47'N, 4°25'E by W158 c. 2 km NW of Ait-Aissi (ENE of Tizi-Ouzou), Algeria 680 m ASL.

This species has a distribution that extends from Oran to Annaba in Algeria, with a doubtful record from Tunisia (Boeters *et al.* 1989). Many of the published distributional records of *A. lallemanti* are dead shells from floodline detritus of rivers (e.g. Bourguignat 1864, Lallemant 1869). These sites were either in river gorges such as 'Gorge de Isser' (= Gorges de Beni Amrane) or at the base of crags or near waterfalls. There are reports of fresh shells from moist rocky places, under stones or amongst mosses, leaf-litter and detritus.

Of the records listed above, only three came from sites where the habitat is identifiable. At two sites the species was found on rock ledges of crags partly shaded by trees (**223**. Sandstone crag partly shaded by oak trees; **232**. Limestone crag with patchy cover of low trees, bushes, herbs and grasses). At the third site the specimens were collected by sieving leaf litter (evergreen oak and oleander) from a woodland floor on nearly flat ground. The woodland appeared to have been burnt several years previously. The other records came from river floodline debris.

A single shell found in floodline debris near Tetouan in NW. Morocco has shell characters similar to *A. lallemanti*. Examination of specimens from Algeria show that this species is rather variable in the size of the shell, shape of the aperture and number of incised grooves on the body whorl (Fig. 1 A–C, Table 1). Although the shell is most similar to *A. lallemanti* there were also some shell characters which differ from the Algerian specimens. In comparison, the Moroccan shell has a rather narrow, tapering apex with a shallower suture providing a less convex whorl profile (Fig. 1D). The incised grooves are more widely spaced than in the majority of Algerian shells, especially on the upper whorls. However, examination of one shell provides insufficient evidence to understand the significance of these differences.

A. lallemanti from Algeria differs from the Alpine species *A. lineata* (Draparnaud) and *A. lineolata* (Pini) in having a proportionately broader shell apex and a more cylindrical, less conical, spire. Hence the narrower apex and the number of incised grooves on the Moroccan shell are more similar to the latter two species. Comparison with *A. lineata* showed the external thickened band behind the peristome to be less developed and hence less raised; the

TABLE 1

Shell measurements of Aciculidae from NW. Africa. * Data from Boeters *et al.* (1989)

Species	No. of Specimens	Length (mm)	Breadth (mm)	Incised ribs on body whorl
<i>A. lallemanti</i> Morocco	1	3.6	1.2	23
<i>A. lallemanti</i> * Algeria		3.0–3.4	1.0–1.2	24–34
<i>A. lineata</i> *		2.8–3.7	1.0–1.3	20–31
<i>A. lineolata</i> *		3.4–4.25	1.2–1.4	26–39
<i>A. algerensis</i> Algeria	5	3.25–3.4	1.1–1.3	11–22
<i>A. algerensis</i> Morocco	13	3.6–4.4	1.2–1.4	14–19
<i>A. norrisi</i>	5	3.0–3.1	1.0–1.1	15–20

Moroccan shell is also larger than most *A. lineata*. *A. lineolata* differs in usually being bigger with more incised grooves on the body whorl and a more developed thickened band behind the peristome (in the mature shells).

This record extends the range of *A. lallemanti* from W. Algeria to N. Morocco. *A. norrisi* Gittenberger & Boeters, 1977, known only from Gibraltar, is rather similar to *A. algerensis* and *A. lallemanti*. However, comparisons of four shells of *A. norrisi* (including two paratypes: Coll. Norris) show that, although this species is usually smaller, there is an overlap in size with the smallest specimens of *A. lallemanti*. As with *A. lallemanti*, the shells of *A. norrisi* are variable but tend to be more slender and to have some of the incised radial lines more widely spaced than in *A. lallemanti*.

Acicula algerensis Gittenberger & Boeters, 1977
(Fig. 1E-F)

Material examined: Holyoak-Seddon Collection, National Museum of Wales

278. 19 August 84, 35°10'N, 5°16'W. N edge of Chechaouén, Morocco 620 m ASL, HS# 1984.386.1, (9 shells).

293. 26 June 86, 35°33'N, 5°21'W by S608 3 km SE of Tetouan (centre), Morocco 120 m ASL, HS# 1986.66.1 (2 shells).

294. 26 June 86, 35°32'N, 5°23'W c. 2 km due S. of Tetouan (centre), Morocco 235 m ASL, HS# 1986.65.1. (2 shells).

This species was described by Gittenberger & Boeters (1977) using museum material from Algeria. Holyoak & Seddon (1985) found shells of *A. algerensis* at Chechaouén showing that this species is apparently endemic to NW Morocco and N Algeria. The Algerian records are all of small numbers of shells from river floodline debris (Gittenberger & Boeters 1977, Boeters *et al.* 1989). There are no shells of *A. algerensis* amongst the museum material of *A. lallemanti* in the Melvill-Tomlin Collection. We have two further records of *A. algerensis* near Tetouan in NW. Morocco (Fig. 2a,b). These extend the range in Morocco north along the limestone part of the Rif mountains. These shells were found in debris accumulated either in fissures or on ledges of limestone crags between at 120–620 m elevation; these crags had little or no shade and were on slopes with patchy cover of grasses, herbs and some scattered bushes.

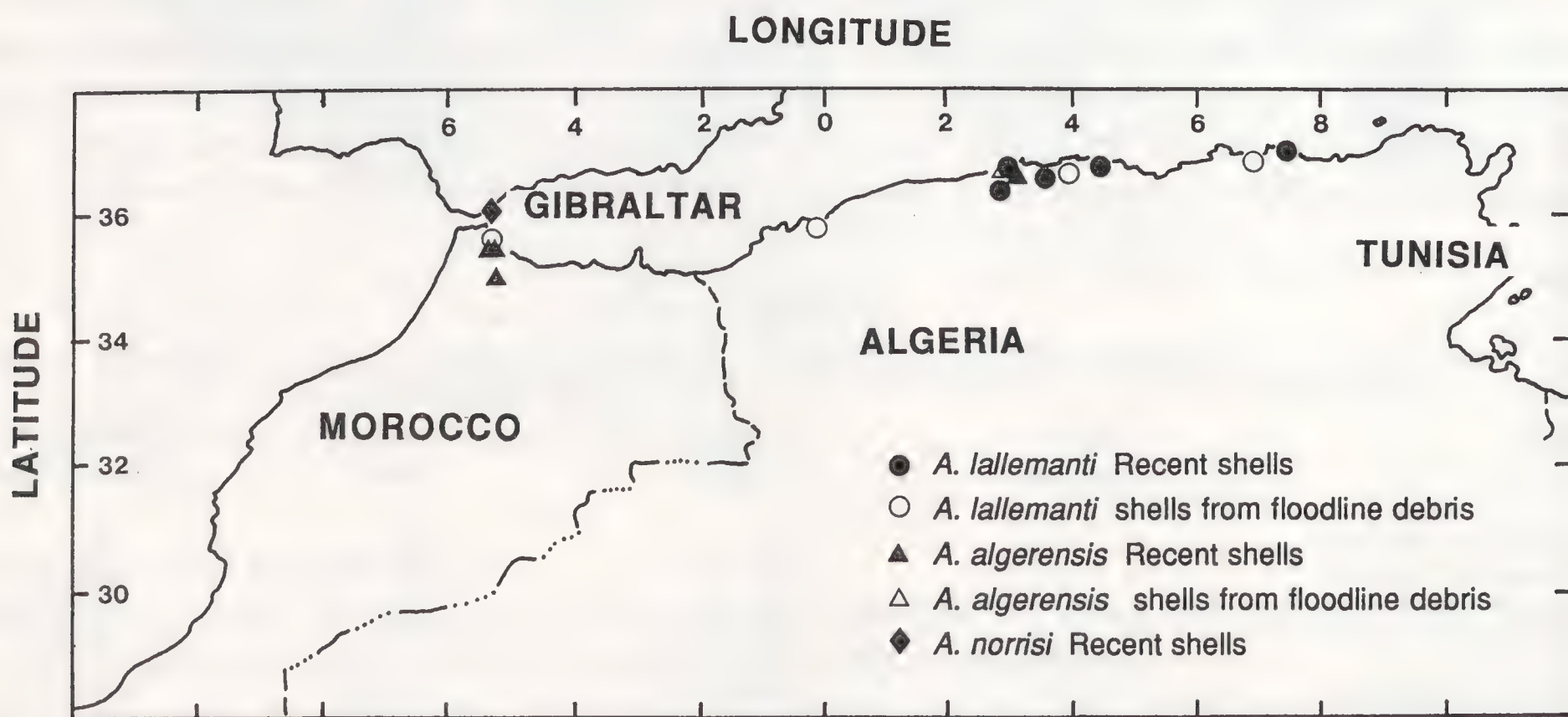


Fig. 2a. Distribution of Aciculidae in NW. Africa.

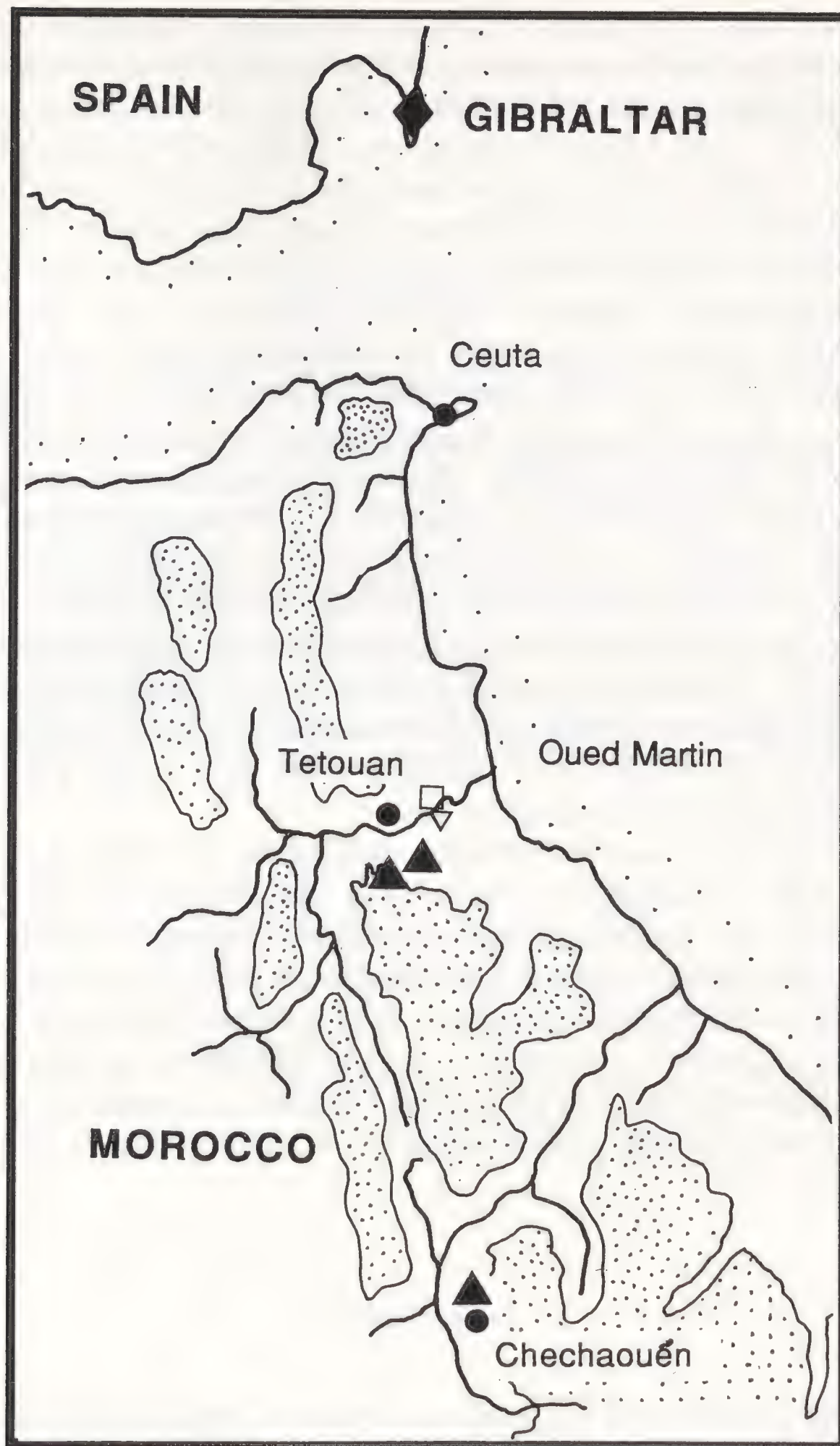


Fig. 2b. Map showing distribution of *Acicula* species in the catchment area of Oued Martin and adjacent regions in Morocco. Closed triangles, *Acicula algerensis* Open inverted triangle, Floodline record of *Acicula lallemanti* and open square, Floodline record of *Platyla cf. polita*. Stippled areas represent mountain ridges.

Most of the Moroccan shells are larger than the few known from Algeria but the ranges apparently overlap (Table 1).

Comparison of four shells of *A. norrisi* (including two paratypes: Coll. Norris) show that this species usually can be separated from *A. algerensis* by its proportionately narrower and smaller shell (Fig. 1 G). However, it resembles *A. algerensis* in having more widely spaced ribbing than *A. lallemanti*. The shells from Morocco have a similar number of incised grooves to *A. norrisi* from Gibraltar. These measurements contrast with more widely spaced grooves on the Algerian specimens reported by Gittenberger & Boeters (1977).

Platyla polita (Hartmann, 1840)
(Fig. 1H)

Boeters *et al.* (1989) and Gittenberger (1991) describe the range of *Platyla polita* in Europe.

Although most records are from central Europe there are outlying records from provinces Alicante and Valencia in SE. Spain, southern Italy and Sicily (Gittenberger 1991).

A single shell of *Platyla* was sieved from floodline debris from beside the Oued Martin (*c.* 5 m A.S.L.) by the S608 road, 5.5 km E. along the road from Tetouan, N. Morocco (35°34'N, 5°19'W) on 27 June 1986. Initial comparisons with *P. polita* from France, Switzerland, Hungary and Czechoslovakia showed differences in some shell characters. The most obvious differences are that the shell apex and upper whorls of the spire are broader (Fig. 1G) and the body whorl proportionately narrower; all the whorls are less convex, giving a more cylindrical (less conical) outline to the shell. The thickened band behind the peristome is less thickened and hence less raised. The columellar axis of the mouth more vertical than the majority of N. African shells. The shell is larger than most (not all) *P. polita* and considerably larger than *P. gracilis* (Clessin, 1877), which otherwise much resembles *P. polita*. In comparison with *P. polita* from SE. Spain (RMNH: leg. Ripken) the specimen is smaller than the majority of shells (height 3.2 mm compared to 2.95–3.85 mm) and narrower; however it is similar in having a conspicuously broad apex and a milky-corneous (pale brown) shell. The Spanish specimens differ from those of central Europe in the conspicuously blunt apex and relatively big shell (Gittenberger, *in litt.*). Although it is possible that the Moroccan shell may merit subspecies status one shell provides insufficient data to support such separation. This is apparently the first record of *P. polita* in NW. Africa and provides a considerable extension to the south-western limits of its range.

The drainage basin of the small river that yielded the floodline debris is quite extensive and covers the area where *A. algerensis* is found (Fig. 2b). Whereas in the northern parts of the range *P. polita* tends to be associated with moderately damp habitats in woodland or on mossy screes, this river passes through farmland with rocky limestone hillslopes adjacent, with little woodland in this region nowadays. It is possible, although by no means certain, that the specimen is a Quaternary fossil. It is thus difficult to determine whether the shell came from a restricted moist habitat somewhere in the catchment today or is a Quaternary fossil from a moister period in the past. Further work in the region is required to establish its status.

DISCUSSION

It is likely that more records will be made as research continues in these regions but it is possible to make a few generalisations about the current records of Aciculidae. At present all the records are from areas close to the Mediterranean coast (Fig. 2). The greatest number of fresh shells come from Chechaouén at the western end of the Rif Mountains (620 m ASL) and Cascades de la Glacière at Blida, near Algiers (1350 m ASL). The majority of the other records come from crags or river valleys within *c.* 30 km of the coast from sea level (as river floodline debris records) with fresh shells recorded at sites up to 200 m elevation.

Most of the sites are relatively moist rocky places with partial shading from either low shrubs or trees; the shells being found amongst mosses, leaf-litter and detritus. These sites are fairly rich in both species diversity and population density in comparison with other sites in North Africa.

ACKNOWLEDGEMENTS

We are grateful to Prof. E. Gittenberger for discussion, comments and the loan of specimens for comparison. Mr. A. Menez and Mr. A. Norris provided comparative material of *Acicula*

norrisi from Gibraltar. Thanks are also due to Dr. P. G. Oliver for the SEM photography and comments on the manuscript. MBS acknowledges support from the Leverhulme Trust. Assistance was also provided by Nuffield Foundation and the Cheltenham & Gloucester College of Higher Education.

REFERENCES

- BOETERS, H. D., GITTENBERGER, E. & SUBAI, P. 1989. Die Aciculidae (Mollusca: Gastropoda, Prosobranchia) *Zool. Verh., Leiden* **252**: 1–234.
- BOURGUIGNAT, J.-R. 1863–1864. *Malacologie de l'Algérie ou histoire naturelle des animaux Mollusques terrestres et fluviatiles recueillis jusqu'à ce jour dans nos possessions du nord de l'Afrique*. Paris, Challamel Aine.
- GITTENBERGER, E. 1991. Zur Verbreitung von *Platyla polita polita* (Hartmann, 1840) (Gastropoda, Prosobranchia: Aciculidae). *Basteria* **55**: 127–128.
- , & BOETERS, H. D. 1977. Some remarks on *Acicula* s.s. (Prosobranchia: Rissoacea). *J. Conch., Lond.* **29**: 125–128.
- HOLYOAK, D. T. & SEDDON, M. B. 1985. An undescribed *Acicula* (Gastropoda: Aciculidae) from Portugal and a record of *A. algerensis* in Morocco. *J. Conch., Lond.* **32**: 63–66.
- LALLEMANT, C. 1869 [for 1868]. Malacologie des environs d'Alger. *Ann. Soc malac. Belgique*, **3**: 15–64.
- , 1881. Catalogue des mollusques terrestres et fluviatiles des environs d'Alger. *Feuille jeun. Nat., Paris* **11**: 83–88.

USE OF ECOLOGICAL PROFILES AND CANONICAL CORRESPONDENCE ANALYSIS IN A STUDY OF THE RELATIONSHIP OF TERRESTRIAL GASTROPODS AND ENVIRONMENTAL FACTORS

A. OUTEIRO¹, D. AGÜERA² AND C. PAREJO²

(Accepted for publication, 16th October, 1993)

Abstract: A study was carried out on the relationship between terrestrial gastropods and several environmental factors in the plains of Aranjuez (Madrid, Spain). Two statistical methods were used: one was autecological (ecological profiles) and the other, synecological (canonical correspondences), comparing information from both. Results show the importance of the influence of soil texture and litter pH on the distribution of terrestrial gastropod species in this area.

Key words: Terrestrial gastropods, autecology, synecology, environmental factors

INTRODUCTION

Different numerical methods may be used to study the relationships between gastropod distribution and environmental factors in a given area. These methods may be autecological, in which each species is studied individually, or synecological, where the community as a whole is involved. Both methods have characteristics that complement each other.

The ecological profiles, described by Daget & Godron (1982) are used as an auteocological method. This technique was originally designed for phytoecological research and is currently being extended to the field of animal ecology (Mascato, Mato, Trigo, Mariño & Diaz Cosin 1985). It has been used by André (1975) and Outeiro, Ondina, Rodriguez and Castillejo (1989) in malacological studies.

The development of synecological methods is linked to multivariate statistical analyses. These analyses have been greatly improved in recent years, with the introduction of techniques specifically designed for ecology, one of which is canonical correspondence analysis (Ter Braak 1986). Studies on zoogeography and animal ecology (Helliövaara, Väisanen & Immonen 1991, Briones, Mascato & Mato 1992) are beginning to use this type of analysis, although it had not been applied to the field of malacology until now.

This article will compare the type of information provided by ecological profiles and canonical correspondence analysis, based on data from a study of terrestrial gastropods in the plains of Aranjuez (Madrid, Spain). This is the first paper providing data relating gastropods to environmental variables in the Mediterranean area of the Iberian Peninsula.

¹ Departamento de Biología Animal (Zoología). Facultad de Biología, Universidad de Santiago de Compostela. 15706 Santiago de Compostela. Spain.

² Departamento de Biología Animal I (Zoología de Invertebrados). Facultad de Biología. Universidad Complutense. 28040, Madrid. Spain.

STUDY AREA

The study area is located in the southern part of the province of Madrid and includes a small strip of the province of Toledo. It comprises the town of Aranjuez, and the adjacent lands of the plains of the Tajo and Jarama rivers, as well as the Ontígola lagoon (Fig. 1).

The lowland plains are made up of Quaternary deposits arranged in terraces on either side of the rivers. Soils are deep, having a neutral or slightly basic pH and are marked by the presence of carbonates.

The area has a temperate Mediterranean climate, where water is plentiful, due to the great number of irrigation channels. The land is arid only in the vicinity of the Ontígola lagoon. The abundant vegetation is composed primarily of woods (*Platanus vulgaris* Spach., *Populus nigra* Linnaeus, *Ulmus campestris* Linnaeus, *Robinia pseudoacacia* Linnaeus), brush (reedbeds, *Juncus* sp., *Fumaria* sp., *Rosa* sp.), cultivated areas (*Avena sativa* Linnaeus, *Zea mays* Linnaeus) and meadows.

MATERIALS AND METHODS

Samples were taken in January, 1988. The map of the area was divided into squares marking 68 zones measuring 1 km² (Fig. 1), in order to sample the valley systematically. In each square a quantitative sample of the gastropods was taken by collecting litter and a layer of topsoil in a 0.5 m² area, according to minimum area results. Specimens were collected using the wet sifting method (Williamson 1959). Only specimens that were alive on collection were used; empty shells were distinguished by their transparency. Each sample was subjected to an analysis of 10 physical and chemical factors, listed with their respective abbreviations as follows: humidity (HUM), gravel (GRA), sand (SAN), silt (fraction between 2–20 μ) (SIL), clay (CLA), pH in H₂O of litter (pHH), pH in KCl of litter (pHK), carbon (C), organic matter (OM) and calcium content of the soil (Ca). Soil analysis were realized according to the methods described by Guitián & Carballas (1976).

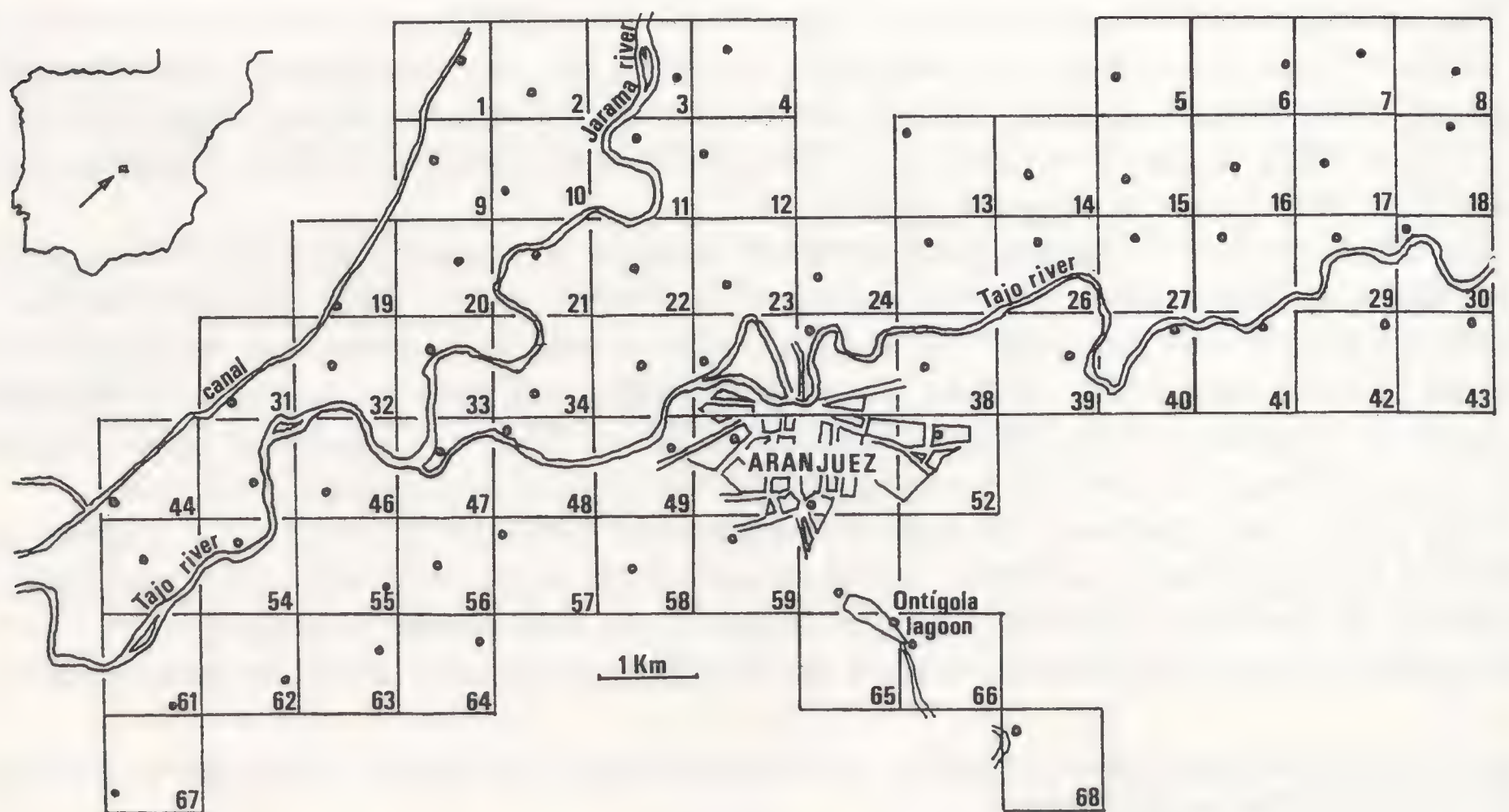


Fig. 1. Map of the study area. Dots show sites where samples were collected.

Data processing was carried out first by means of correspondence analysis, using the matrix of number of individuals (log-transformed). The main objective of this analysis is to describe the community structures of a certain area, establishing species associations as a function of their distributions.

A second step was to use ecological profiles technique. The purpose of this analysis was to study the behaviour of each species as compared to each factor measured, with its variation intervals divided into classes. Class intervals were determined in terms of inflection points on the curve of accumulated frequencies (Daget & Godron 1982). Species preference by class was obtained using corrected frequency profiles. The confidence coefficient for each profile (Gauthier, Godron, Hiernaux & Lepart 1977), barycenters and regional ecological amplitude were also calculated.

A canonical correspondence analysis was also done, using the following matrices: number of individual and environmental factors, both log-transformed. The analysis was performed by downweighting the rare species, using the method proposed by Ter Braak (1988). According to this method, species with one-fifth of the maximum frequency found are considered to be rare. We used the CANOCO v3.1 program (licence no. 4221). Further information on this analysis can be found in Jongman, Ter Braak & Tongeren (1987) and Ter Braak (1988).

RESULTS

Of the 68 samples collected, 9 did not contain live specimens. We found a total of 15 species (Tab. 1), two of which, *V. contracta* and *T. pusilla* appeared in only one sample (Tab. 2), therefore they were omitted from the analyses.

Table 3 and Figure 2 show the results of correspondence analysis. As can be seen in the figure 2, axis I separates to its positive edge *V. pulchella* followed by *R. decollata*, *C. virgata* and *C. barbara*, from the rest of species. Axis II separates, to its positive side, *O. draparnaudi*, *C. barbara*, *C. cespitum* and *C. virgata* from the group formed by *V. pulchella*, *R. decollata* and *C. vestita*. These species groups are not related to vegetation types (Tab. 2), except *V. pulchella* appearing in meadows frequently.

Ecological Profiles

Class intervals for each factor are given in Table 4. Four classes were established for clay and slime and three for the other factors. In order to obtain an estimate of the degree of information provided by the factors in relation to the species as a group, the entropy factor was expressed in terms of the mean of the joint species-factor information (Fig. 3). The

TABLE 1. Species found in the samples

Abr.	Species	Abr.	Species
Cba	<i>Cochlicella barbara</i> (Linnaeus, 1758)	Rde	<i>Rumina decollata</i> (Linnaeus, 1758)
Cce	<i>Cernuella cespitum</i> (Draparnaud, 1801)	Tca	<i>Truncatellina callicratis</i> (Scacchi, 1833)
Cve	<i>Cernuella vestita</i> (Rambur, 1868)	Tpi	<i>Theba pisana</i> (Müller, 1774)
Cvi	<i>Cernuella virgata</i> (Costa, 1778)	Tpu	<i>Toltecia pusilla</i> (Lowe, 1831)
Has	<i>Helix aspersa</i> (Müller, 1774)	Vco	<i>Vallonia costata</i> (Müller, 1774)
Hco	<i>Helicella conspurcata</i> (Draparnaud, 1801)	Vcn	<i>Vitrea contracta</i> (Westerlund, 1871)
Mca	<i>Monacha cartusiana</i> (Müller, 1774)	Vpu	<i>Vallonia pulchella</i> (Müller, 1774)
Odr	<i>Oxychilus draparnaudi</i> (Beck, 1837)		

TABLE 2. Number of specimens and vegetation type in each sample. (Abbreviations of the species in Table 1. Abbreviations for vegetation types, "W": wood; "B": brush, "C": cultivated area, "M": meadow, "D": bank of irrigation ditch, "R": bank of river).

No	Species															Vegetation					
	Cba	Cce	Cve	Cvi	Has	Hco	Mca	Odr	Rde	Tca	Tpi	Tpu	Vcn	Vco	Vpu	W	B	C	M	D	R
2															2						
4			17																		
5		2					2														
6	1													2							
7		1																			
9			1																		
10			5																		
11							5		2												
12		7	5			6			4												
13			2																		
14		1							7					1	1						
15											1										
16			87							2				4							
17	35	4					7							3							
18			8																		
20			112									86		6							
21									3					1	13						
22	5	10		1				1													
23			23			136			1					105							
24		9	4		3		2							3							
25			10																		
26	5	8	1							6				10							
27			9																		
28		2	2		1		4														
29	1		11			19	16			7			1	20							
30	1																				
31					2																
32			5																		
33							1														
34							3														
35		5												1							
37	10					9															
38		3																			
39		5	5							1	1			1							
40	1		36				10							14							
41			7							1				1							
42		1	6	1																	
43			3				1			3											
44															1						
45	12						3														
47			1																		
48	1		4											2							
49	14					262	12		4					1							
50	14			1										2	16						
52			6																		
53															7						
55	12	2	3	1		6	3				3										
56									28					1							
57			1				1														
58			6			41															
59			3			14															
60	1																				
61			10											2							
62			1		1				1												
63		1																			
65			7								2										
66	3																				
67			10			1															
68		14	6				3	1													



Fig. 2. Correspondence analysis. Projection of species and samples on the plane defined by axes 1–2. Abbreviations of the species same as in Table 1 and characteristic of samples in Table 2.

TABLE 3. Correspondence analysis. Eigenvalues, inertia percentages and signification for the first three axes.

Axis	eigenvalue	inertia%	χ^2	f.d.	Sign
1	0.672	18.6	94.08	69	p<0.05
2	0.509	14.7	71.26	67	
3	0.445	12.2	62.30	65	

factors that stand out as efficient, that is, those that predictably best explained species distribution (Daget & Godron 1982) are clay, gravel, sand, pH in KCL of litter and calcium.

The corrected frequency profiles indicate the preferences of each species. The degree of preference is shown by profile values over 1. Fig. 4 represents the profiles whose confidence coefficients showed significant results. Table 5 summarizes the results of the efficient factors as compared to every species.

The barycenters, a concept similar to the ecological optimum (Daget & Godron 1982), sum up the information provided by the corrected frequency profiles, and enables us to order

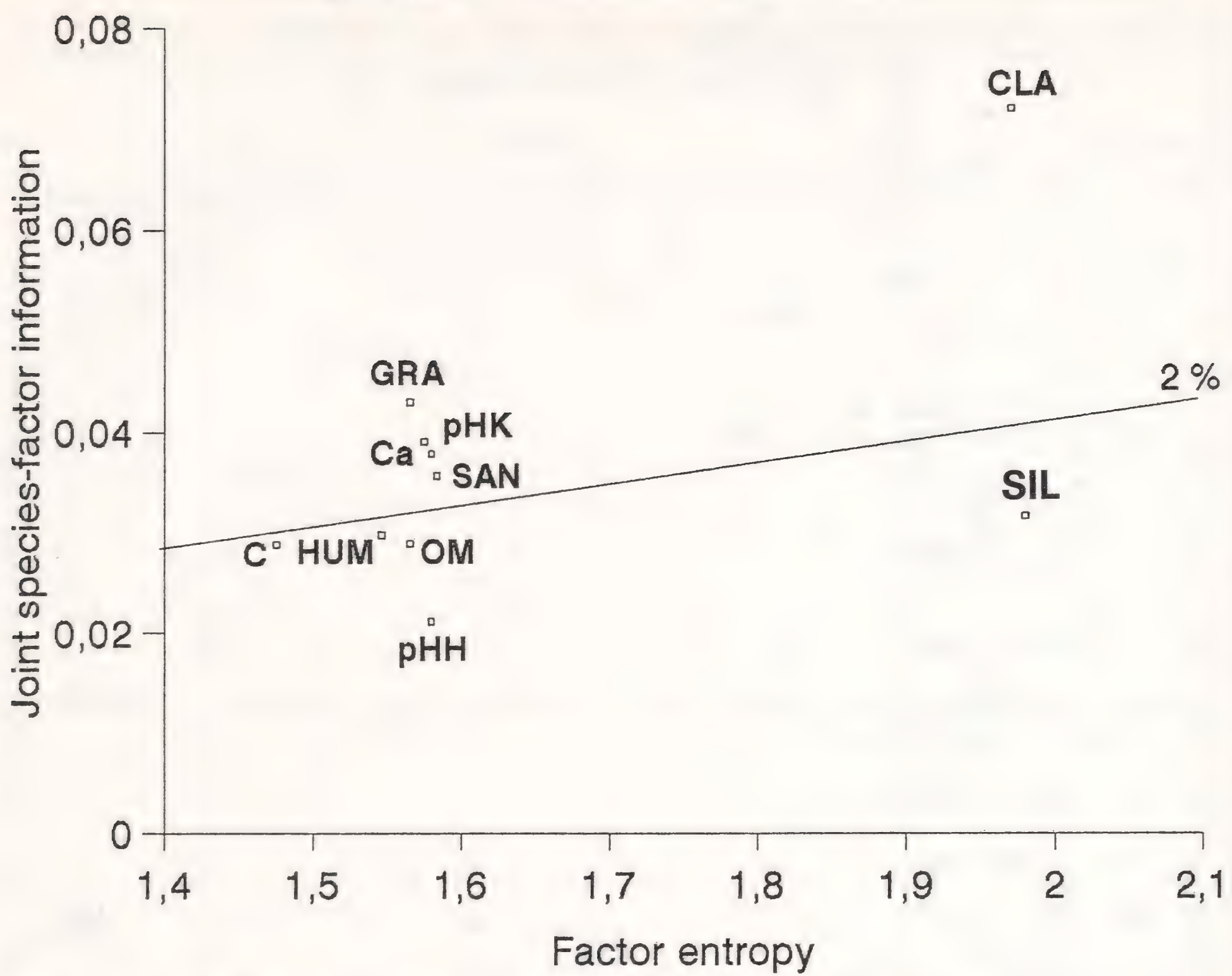


Fig. 3. Ecological Profiles. Relationship between the entropy observed for each factor and the mean of the joint species-factor information (Units in bits). Abbreviations of the environmental factors in text.

TABLE 4. Ecological profiles. (1): classes. (2): Class intervals for each factor. (3): Number of samples that make up each class. (Units: % for HUM, GRA, CLA, SIL, SAN, C; meq/100 grs. for Ca). Abbreviations of the environmental factors in text.

	(1)	(2)	(3)		(1)	(2)	(3)
HUM	1	9.0-23.0	18	GRA	1	0.0 - 1.0	19
	2	23.1-31.0	26		2	1.1 - 6.0	24
	3	31.1-46.1	15		3	6.0 -27.7	16
CLA	1	2.8- 4.5	15	SIL	1	4.3 - 9.0	13
	2	4.6- 6.5	17		2	9.1 -12.0	13
	3	6.6-10.5	17		3	12.1 -14.0	14
	4	10.6-20.6	10		4	14.1 -25.6	19
SAN	1	67.0-79.0	21	pHH	1	7.2 - 7.7	19
	2	79.1-83.0	19		2	7.8 - 7.9	18
	3	83.1-92.5	19		3	8.0 - 8.5	22
pHK	1	6.9- 7.3	23	C	1	0.90- 3.39	28
	2	7.4- 7.6	18		2	3.40- 5.80	21
	3	7.7- 7.9	18		3	5.81-14.61	10
OM	1	1.7- 5.5	24	Ca	1	2.7 -17.5	18
	2	5.6- 8.7	16		2	17.6 -26.5	22
	3	8.8-25.2	19		3	26.6 -52.5	19

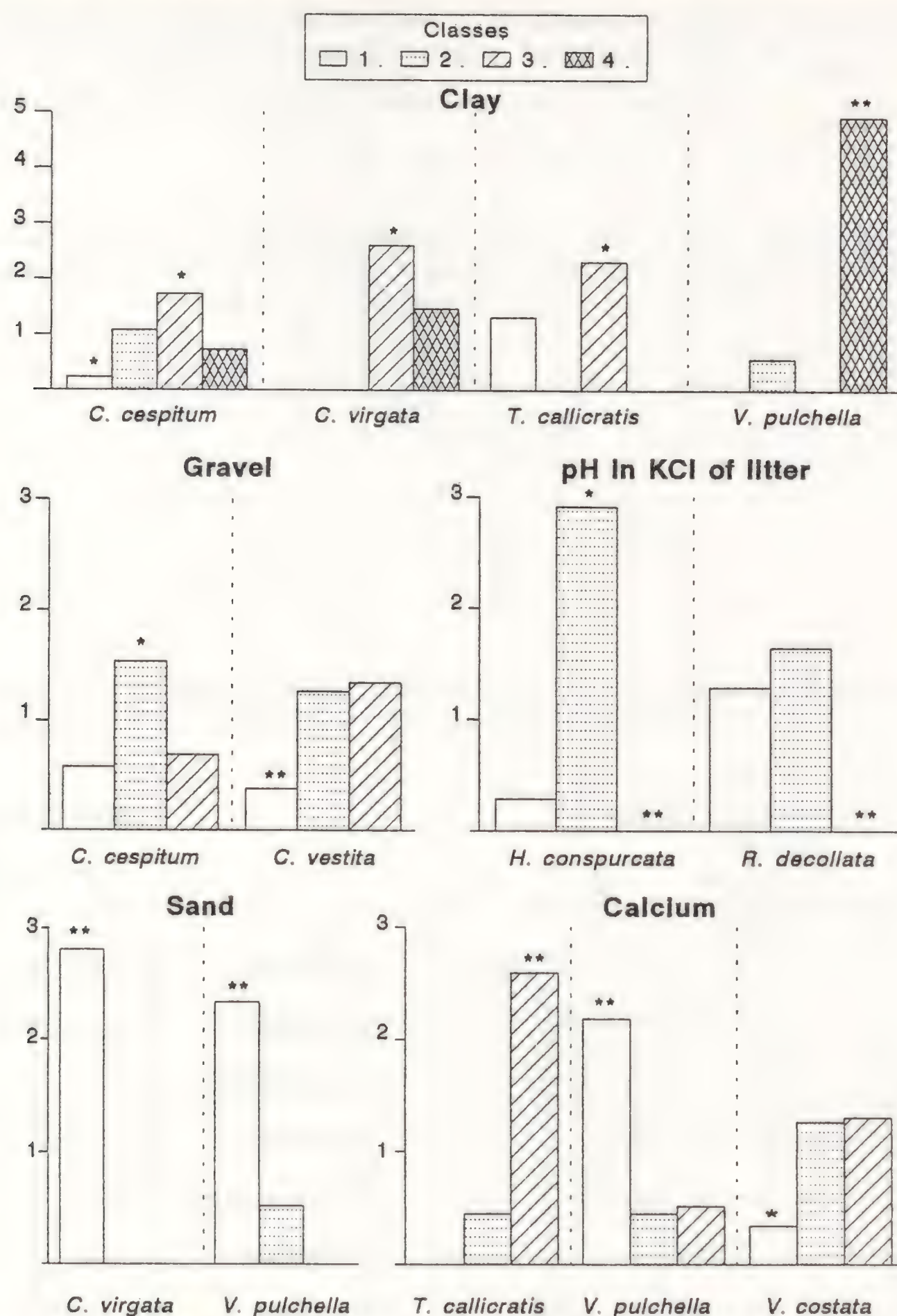


Fig. 4. Ecological Profiles (/100). Significant results of corrected frequency profiles. “*”: $p < 0.05$; “**”: $p < 0.01$.

the species according to their preferences by factor classes. Regional ecological amplitude shows the range of factor values in which the species is present. For example, in Figure 5, the barycenters and regional ecological amplitude of the species are expressed in terms of two of the efficient factors: clay and pH in KCl of litter.

The results obtained from ecological profiles show that, in addition to the influence of calcium and pH, a relationship exists between the gastropods and factors related to soil texture. The most influential factor in gastropods is clay, followed by gravel.

Canonical Correspondences

Canonical correspondence analysis is a multivariate ordination method, which arranges the species in terms of environmental factors instead of samples. Ordination is based on the unimodal response of the species compared to the linear combination of the factors.

In order to determine the goodness of the analysis, the Monte-Carlo permutation test was calculated for the first axis (Hope 1968, in Ter Braak 1988). The results were as follows:

TABLE 5. Ecological profiles. Summary of results. “↑”: preference for value class of the factor; “↓”: rejection of the class (Class intervals for each factor in Table 4).

	Clay				Gravel			Sand			pH in KCI			Calcium		
	1	2	3	4	1	2	3	1	2	3	1	2	3	1	2	3
<i>C. barbara</i>			↑		↑			↑		↑		↑	↑		↑	↑
<i>C. cespitum</i>		↑	↑			↑		↑		↑		↑	↑		↑	↑
<i>C. vestita</i>	↑↓		↑			↑	↑		↓	↓		↑	↑			↑
<i>C. virgata</i>	↓	↓	↑	↑		↑	↓	↑	↓	↓		↑				↑
<i>H. aspersa</i>	↓			↑↓		↑	↓	↑					↑↓		↑	
<i>H. conspurcata</i>			↑	↓		↑	↑		↑			↑	↓	↑		
<i>M. cartusiana</i>		↑			↑	↑		↑		↑			↑		↑	↑
<i>O. draparnaudi</i>	↑		↑	↓	↑		↑	↑		↑	↑		↑	↓	↑	↓
<i>R. decollata</i>		↑		↑	↑				↑		↑		↓		↑	
<i>T. callicratis</i>	↑		↑	↓			↑			↑		↑		↓		↑
<i>T. pisana</i>	↑		↑	↓	↓	↑	↑	↑				↑				↑
<i>V. costata</i>		↑			↑		↑					↑			↑	↑
<i>V. pulchella</i>	↓			↑	↑		↓	↑		↓	↑	↑	↓	↑		↑

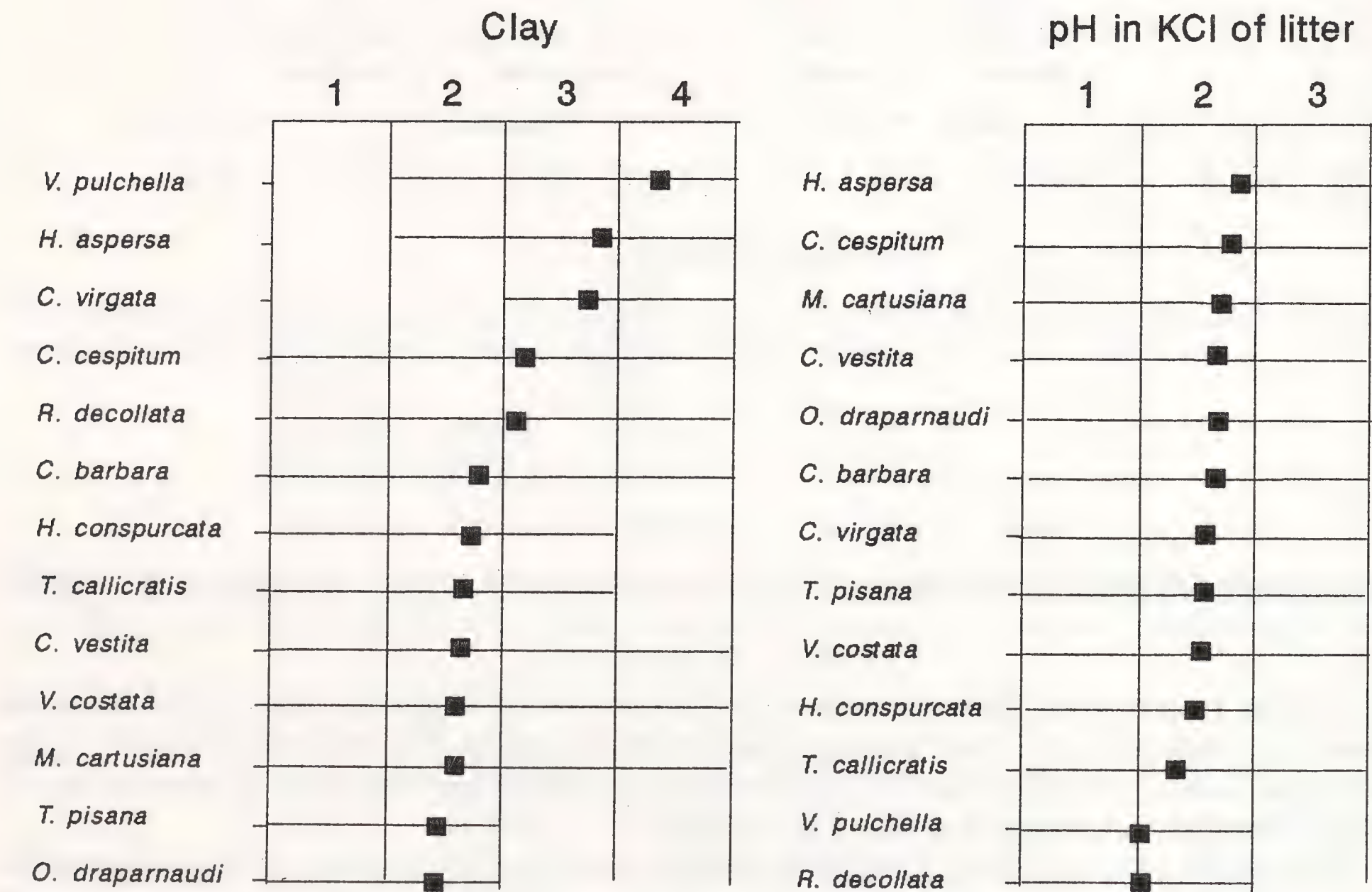


Fig. 5. Ecological profiles. Barycenter results (squares) and regional ecological amplitude (horizontal lines) of species for clay and pH in KCI of litter.

F-ratio = 6.16, $p < 0.01$. Another way of finding out the goodness of the analysis is to compare the species-factor correlation coefficient to the one found with the correspondence analysis (Ter Braak 1986) using the same data. The results are shown in Table 6, where we can see that both values are very similar in the first two axes. Moreover, it can be seen that

species ordination in correspondence analysis (Fig. 2) is quite similar to the ordination obtained from the canonical correspondence analysis. This suggests that the factors measured give a satisfactory explanation of species distribution.

TABLE 6. Canonical correspondences. Eigenvalues, inertia percentages, species-factor correlation of the Canonical Correspondence Analysis (CCA) and species-factor correlation of the Correspondence Analysis (CA) for the first three axes.

Axis	eigenv.	inertia%	sspp-fact. correlation CCA	sspp-fact. correlation CA
1	0.441	11.4	0.799	0.756
2	0.211	5.8	0.678	0.558
3	0.138	3.8	0.599	0.413

TABLE 7. Canonical correspondences. Significant results of the Axis-Factor correlation for the first two axes. Significance: “*”: $p < 0.05$; “***”: $p < 0.01$.

Factor	Axis 1	Axis 2
Clay	0.438**	—
Sand	−0.434**	−0.299*
pH in KCl of litter	−0.423**	—
Calcium	−0.369**	—
Gravel	−0.349**	−0.273*
Slime	—	0.312*

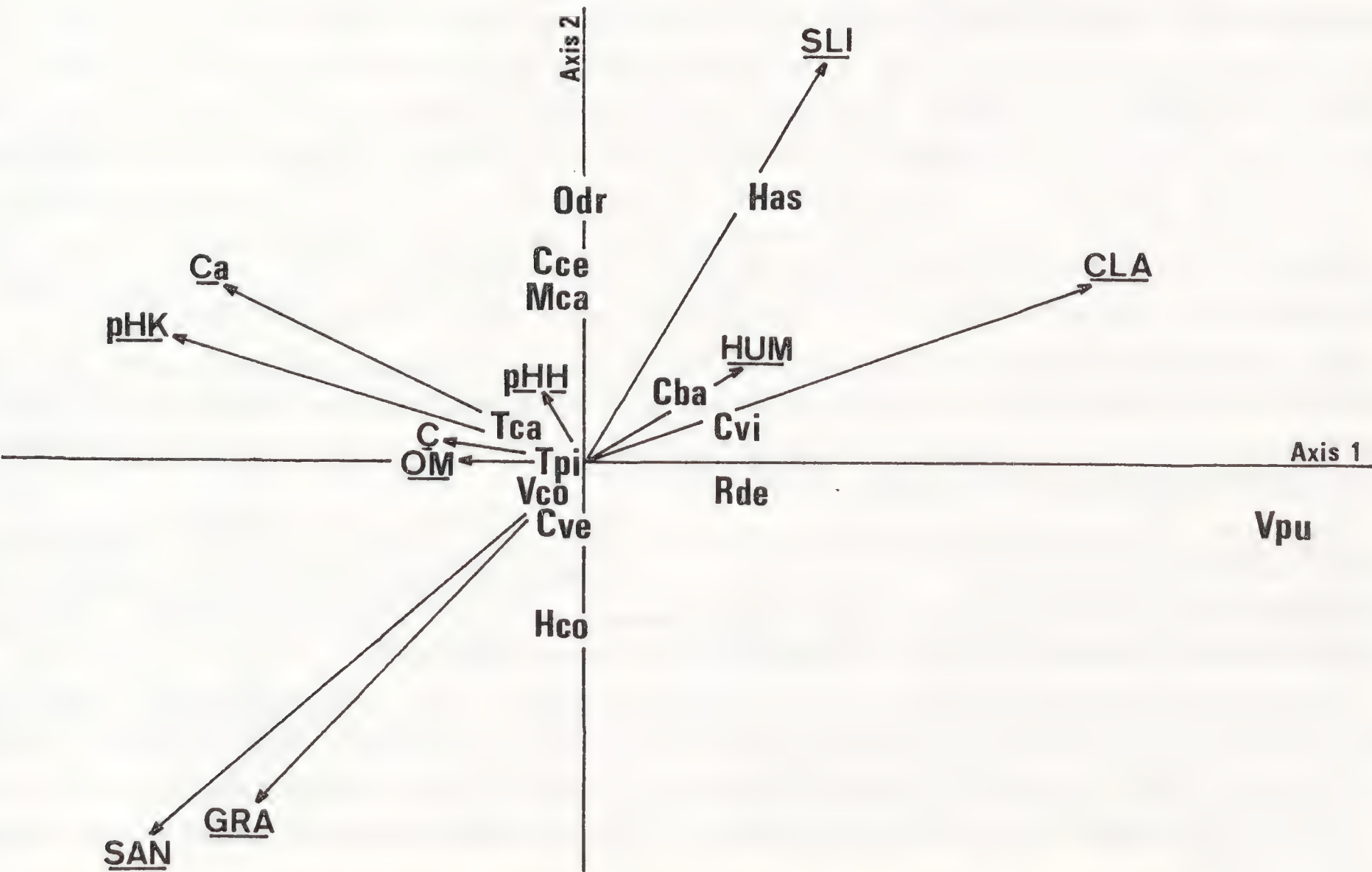


Fig. 6. Canonical correspondences. Projection of species and factors on the plane defined by axes 1–2. Abbreviations of the species same as in Table 1 and abbreviations of the environmental factors in text.

Table 7 shows the factors that correlate significantly with axes 1 and 2. In this table we can observe that the factors that best explain species distribution are those related to soil texture, calcium and pH.

Fig. 6 gives the results for axes 1 and 2. Species are expressed by points and environmental factors by arrows. The greater the influence of the factor, the longer the arrow will be. Each arrow determines an axis to be extended in both directions. The projections of the species on this axis will show the preference gradient for high or low values of the factor. So, if we consider clay, we can see that *V. pulchella* prefers the highest values of this factor, followed by *H. aspersa*, *C. virgata*, *R. decollata* and *C. barbara*, whereas the other species prefer average values or show no preferences. We can see the opposite behaviour in terms of sand and gravel. As far as pH in KCI of litter and calcium are concerned, *V. pulchella* stands out in terms of its preference for low values of these factors.

DISCUSSION

The results obtained using the two analyses coincide in reporting soil texture, calcium and litter pH as the factors that best explain terrestrial gastropod distribution on the plains of Aranjuez (Fig. 3 and Table 7). Another finding that agrees in both analyses is the species response to each factor. So, for example, with the ecological profiles technique (Table 5), we see that *V. pulchella* shows a preferences for high clay values and low gravel, sand, pH in KCI and calcium values. The same is found using the canonical correspondence analysis (Fig. 6). Moreover, species ordination according to their preferences for high or low values of a factor are similar in both analyses. This may be confirmed if we compare the barycenters (Fig. 5) to the projection of the species on the factor axes (Fig. 6).

However, the type of information provided by the ecological profiles is different in other ways. Since it is an autecological method, ecological profiles allow us to determine which factors are critical for each species. In order to do this, we must substitute the mean of the joint species-factor information in Fig. 3, with the value obtained for each species. Also, with ecological profiles, it is possible to determine the species' preference for mean values of the factor (for example: *H. conspurcata* in terms of pH in Fig. 4), distinguishing it from an indifferent behaviour (for example: *O. draparnaudi* with sand and pH in Tab. 5). Lastly, the ecological profiles technique allows for the detection of stenoecious behaviour and indicates the intervals of the factor values in which the species is present (for example: *C. virgata*, *T. pisana* and *O. draparnaudi* with clay or *V. pulchella*, *H. conspurcata* and *R. decollata* for pH in Fig. 5).

The advantage of canonical correspondence is that it shows us, with only one graph, the behaviour of the community in terms of the factors measured. It also allows us to establish associations of species having similar behaviour with the total group of factors (for example *C. barbara*, *C. virgata* and *R. decollata* in Fig. 6).

Therefore the two techniques are complementary and the use of the two together will provide information on both the community as a whole and on each individual species. The results obtained refer exclusively to the study area, as the intervals of the factor values may change in other locations, thereby affecting the species differently.

The most important finding was the relationship between soil texture and gastropod distribution. This influence had already been suggested by Boycott (1934), Kühnelt (1957), Stephenson (1966), Peake (1978) and Outeiro *et al.* (1989). These authors attribute this to the fact that the gastropod has a limited capacity for burrowing into the soil where it lays its eggs or seeks refuge.

However, it is still not clear what advantages or disadvantages certain soil textures would hold for the species. Kühnelt (1957) suggests that there is a relationship between

species size and the texture of the soil on which they live. According to this author, in areas having fine textured soil, such as meadows, smaller sized species occur. However, the results from this article show that species showing preferences for fine textures, such as *V. pulchella*, *H. aspersa*, *C. virgata*, *R. decollata* and *C. barbara*, with the exception of *V. pulchella*, are relatively large in size. *V. pulchella* is the only species that complies with Kühnelt's (1957) findings, as it is common in meadows and may be buried in the surface layer of soil. Due to their larger size, the remaining species may have greater mobility and be able to seek refuge without having to bury themselves in the ground, which means that they would not be directly affected by soil texture.

As far as litter KCI and calcium in the soil are concerned, the preferences of the species for these factors are very similar (Table 5 and Fig. 6). Both factors give a satisfactory explanation of the differences in the gastropod fauna at different sites. However, the pH in KCI of litter appears to be a better indicator (Fig. 3 and Table 7). This agrees with Bishop's (1977) findings, where he reports that the chemical factors in the litter offer a better explanation of species distribution than the chemical factors in the soil.

REFERENCES

- ANDRÉ, J. 1975. Ecologie du gastéropode terrestre *Cepaea nemoralis* Linné, en Languedoc et en Roussillon. *Vie Milieu* **25** (1, C): 17–47.
- BISHOP, M. J. 1977. The mollusca of acid woodland in West Cork and Kerry. *Proc. R. Ir. Acad. B* **77**: 227–244.
- BRIONES, M. J. I., MASCATO, R. & MATO, S. 1992. Relationships of earthworms with environmental factors studied by means of detreted canonical correspondence analysis. *Acta Oecologica* **13**, no 5 (in press).
- BOYCOTT, A. E. 1934. The habitat of land mollusca in Britain. *J. Ecol.* **12**(1): 1–38.
- DAGET, P. H., & GODRON, M. 1982. *Analyse de L'écologie des espèces dans les communautés*. Paris, 163 pp.
- GAUTHIER, B., GODRON, M., HIERNAX, P. & LEPART, J. 1977. Un type complémentaire de profil écologique: Le profil écologique "indicé". *Can. J. Bot.* **55**: 2859–2865.
- GUITIAN, F. & CARBALLAS, T. 1976. *Técnicas de análisis de suelos*. Ed. Pico Sacro, Santiago. 288 pp.
- HELIÖVAARA, K., VÄISÄNEN, R. & IMMONEN, A. 1991. Quantitative biogeography of the bark beetles (Coleoptera, Scolytidae) in Northern Europe. *Acta Forest. Fennica* **219**: 5–35.
- JONGMAN, R. H. G., TER BRAAK, C. J. F. & VAN TONGEREN, O. F. R. 1987. *Data analysis in community and landscape ecology*. Centre for Agricultural Publishing and Documentation (Pudoc), Wareningen. 299 pp.
- KERNEY, M. P. & CAMERON, R. A. D. 1979. *A field guide to the land snails of Britain and North-west Europe*. Collins, London. 288 pp.
- KÜHNELT, W. 1957. *Biología del suelo*. CSIC., Madrid. 267 pp.
- MASCATO, R., MATO, S., TRIGO, D., MARIÑO, F. & DIAZ COSIN, D. J. 1987. Factores del suelo y distribución de las lombrices de tierra en dos zonas de Galicia: Comparación de diferentes métodos estadísticos. *Rev. Écol. Biol. Sol.* **24**(2): 111–135.
- OUTEIRO, A., ONDINA, P., RODRIGUEZ, T. & CASTILLEJO, J. 1989. Estudio autoecológico de *Punctum (P.) pygmaeum* (Draparnaud, 1801) (Gastropoda, Pulmonata) en la sierra de O Courel (Lugo, España). *Rev. Écol. Biol. Sol.* **26**(4): 515–525.
- PEAKE, J. 1978. Distribution and ecology of *Stylommatophora*. 429–526. In: Ed. Fretter & Peake, *Pulmonates*, Vol. 2a. *Systematics, evolution and ecology*. London. 540 pp.
- TER BRAAK, C. J. F. 1986. Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology* **67**(5): 1167–1179.
- , 1988. *CANOCO a FORTRAN program for canonical community ordination by (partial) (detreted) (canonical) correspondence analysis, principal components analysis and redundancy analysis*. TNO Institute of Applied Computer Science, Wageningen. 95 pp.
- WILLIAMSON, M. H. 1959. The separation of molluscs from woodland leaf-litter. *J. Anim. Ecol.* **28**(1): 153–155.

KEY TO THE IDENTIFICATION OF THE SLUGS (GASTROPODA: PULMONATA) OF PORTUGAL

T. RODRIGUEZ¹ AND J. HERMIDA¹

(Accepted for publication, 16th October, 1993)

Abstract: A key to the Portuguese land slugs is presented. It includes several taxonomic features not used in previous keys, and relies mainly on characters of the distal genitalia, especially the stimulator.

Resumen: Se presenta una clave de identificación de las babosas recogidas en Portugal, en la que se incluyen algunos caracteres taxonómicos no empleados en claves anteriores, destacando entre ellos la anatomía del aparato genital y de los órganos estimuladores.

Key words: Slugs, Gastropoda, Pulmonata, identification, key, Portugal

INTRODUCTION

The study of the Portuguese slug fauna has until recently lagged behind the rest of Europe. There has been little research building on that of the last century, such as Morelet (1845, 1877), Mabille (1868), Pollonera (1887, 1889 and 1890a,b,c), Simroth (1886–1893), Collinge (1897) and Caziot (1915).

No significant advances were made in the present century until the monographs of Nobre (1930, 1941). However, he synonymised several species now considered to be valid, and omitted others which have since been confirmed in Portugal. More recent authors have concentrated on particular species-groups or Families: among these, the works of Seixas (1976, 1977, 1978), Castillejo, Díaz Cosín, Calvín & Mascato (1984), Rodríguez (1985, 1990), Rodríguez, Castillejo & Outeiro (1989), Castillejo, Rodríguez & Outeiro (1989), Rodríguez, Ondina, Outeiro & Castillejo (1993) have clarified the status of many forms.

None of these papers provides a key to the Portuguese species. Keys to the slugs of other European countries are available (Lessona & Pollonera 1884; Taylor 1907; Adam 1960; Quick 1960; Cameron, Eversham & Jackson 1983; Wiktor 1973, 1983); but these do not include all the Portuguese species, only those which are geographically widespread. Several species have been described which are so far known only from Portugal, although it is likely that many of these will also be found in Spain.

The difficulties caused by the lack of a comprehensive key to Portuguese slugs are exacerbated by the problems in identifying slugs using external characters. The almost complete absence of an external shell, coupled with great variability in coloration and size in many species, make it necessary to resort to features of internal anatomy, especially the genitalia, for species identification. Moreover, most of the descriptions based on Portuguese material rely on too few specimens, often without precise localities (e.g. *A. dasilvae* Pollonera). In some cases, the external morphology was described from specimens from one locality, and the internal anatomy based on material from elsewhere; so some taxa were confounded with others, while several different names may have been given to variants of a single species.

¹ Departamento de Biología Animal, Facultade de Biología, Universidade de Santiago de Compostela, E-15706 Santiago de Compostela, La Coruña, Spain.

For all these reasons, the key which follows is based entirely on specimens collected by us in Portugal.

MATERIALS AND METHODS

Material has been collected at 72 localities throughout Portugal, between 1983 and 1987. The specimens collected were considered to represent 24 species belonging to six families. In determining specimens, all the available literature has been reviewed and reconsidered. The status of several species described from Portugal in the last century has been revised, and some have now been synonymised.

SITES STUDIED

A tabulation of localities sampled with the UTM 10×10 km co-ordinates are included. The species are mapped on a 10×10 km grid, with the 100 km grid lines shown (Figs 9 & 10).

GERES, Caldelas, 29TNG51; Pontefia, 29TNG72; Portela do Home, 29TNG72; Cruceiro de Sao Joao, 29TNG72; Curral de Leonte, 29TNG72; Sao Bento da Porta Aberta, 29TNG61; Covide, 29TNG62; Caldas de Gerês, 29TNG62; Albergaria, Viveiro das Trutas, 29TNG72; Viveiro das Trutas, 29TNG72.

MONTALEGRE, Pisos, 29TPG92.

CHAVES, 29TPG22; Carvalhelhos, 29TPG01; Quintás, 29TPG10; Pedras Salgadas, 29TPG10; Vidago, 29TPG11.

OEIRAS, 29SMC79.

SERRA DE MONCHIQUE, Road from Monchique to Foia, 29SNB32; Marmeleite, 29SNB23; Caldas de Monchique, 29SNB32; Monchique, 29SNB33; Alferce, 29SNB43; 5 km to Monchique in direction to Alferce, 29SNB43; Foia, 29SNB33.

MOURA, 29SPC32.

ABRANTES, 29SND66; Constância, 29SND57; Alvega, 29SND86; Areia, Alvega, 29SND86.

COIMBRA, Pena, Portunhos, 29TNE36; Ança, 29TNE45; Luso, 29TNE56.

BRAGANÇA, 29TPG83; Between Alto de Nogueira and Rebordãos, 29TPG72; Rabal, 29TPG83; Gimonde, 29TPG93; Near Rabal, 29TPG71.

SERRA DA ESTRELA, Vila de Cortez, 29TPE28; Seia, 29TPE07; Guarda, in direction of Seia, 29TPE48; Caldas de Manteigas, 29TPE27; Sabugueiro, 29TPE17; Folgoso, 29TPE28; Gouveia, 29TPE18; Nossa Senhora do Desterro, 29TPE17; Sao Romão, 29TPE07; Chaos, 29TPE48; Sameiro, 29TPE27; Cross-roads of Guarda-Manteigas with Gouveia, 29TPE17; Faia, 29TPE49.

SERRA DO CALDEIRAO, Barranco do Velho, 29SNB92; Ameixal, 29SNB93; Alportel, 29SNB91.

LAGOS, Cape Sao Vicente, 29SNA09; Sagres, 29SNA09; Vila do Bispo, 29SNB00; Figueira, 29SNB20.

ESTREMOZ, Veios, 29SPD21; Fronteira, 29SPD12; Monforte, 29SPD21; 29SPC19.

GRANDOLA, Santiago do Cazém, 29SNC20; Alcaçer do Sal, 29SNC44.

MONTEMOR-O-NOVO, 29SNC67; Foros de vale Figueira, 29SNC59; Vendas Novas, 29SNC48.

SERRA DA ARRABIDA, 29SNC06.

FERREIRA DO ALENTEJO, 29SNC71; Ervidel, 29SNC80; Figueira de Cavaleiros, 29SNC61.

RIO MAIOR, Almoester, 29SND14; Sao Joao da Ribeira, 29SND14; Santarem, 29SND14.

FATIMA, Caxarias, 29SND49; Vila Nova de Ourém, 29SND39.

23 km to Castelo Branco in direction of Guarda, 29TPE33.

CASTELO BRANCO, 29SPE21.

VILA NOVA DE FOZ-COA, 29TPF55.

SAO PEDRO DO SUL, 29TNF71; Oliveira de Frades, Natural Reserve of Cambarinho, 29TNF60; Poças, 29TNF70; Pes de Pontes, 29TNF70; Vouzela, 29TNF70; Crescido, 29TNF80.

Trindade, (Road from Macedo de Cavaleiros to Vila Nova de Foz-Côa), 29TPF68.

PENAFIEL, Constance, 29TNF75; Marco de Canaveses, 29TNF75; Agrela, Marco de Canaveses, 29TNF75; Trindade, Constance, 29TNF75.

VIANA DO CASTELO, 29TNG12; Ponte de Lima, 29TNG32; Mirador de Sao Silvestre, 29TNG11; Sao Salvador da Torre, 29TNG11.

BRAGA, SAMEIRO, 29TNF59; TAIPAS, 29TNF59.

BARCELOS Feitos, 29TNG20.

11 km from Barcelos in direction of Viana, 29TNG20.

VISEU, Paradela, 29TNF50.

SERPA, 29SPC20.

SINTRA, 29SMC69; Monserrate, 29SMC59; Lagoa Azul, 29SMC59.

VILA REAL, Bouça, 29TPF07.

MONTEMOR-O-VELHO, Pereira, 29TNE24.

SYSTEMATIC LIST

The list includes slugs that we have found in continental Portugal. Nomenclature follows Likharev & Wiktor (1980). Common synonyms are given alongside in roman italics.

Phylum MOLLUSCA

Class GASTROPODA

Subclass PULMONATA

Superorder STYLOMMATOPHORA

Order SIGMURETHRA

Suborder AULACOPODA

Superfamily LIMACOIDEA

Family AGRIOLIMACIDAE

Deroceras laeve (Müller, 1774): *Limax brunneus* Draparnaud, 1801; *Limax gracilis* Rafinesque, 1820; *Limax parvulus* Normand, 1852.

Deroceras panormitanum (Lessona & Pollonera, 1882): *Agriolimax pollonerae* Simroth, 1889; *Agriolimax caruanae* Pollonera, 1891; *Agriolimax ceconii* Pollonera, 1896; *Agriolimax dubius* Hoffmann, 1941.

Deroceras reticulatum (Müller, 1774): *Agriolimax pallidus* Schrenk, 1848.

Deroceras nitidum (Morelet, 1845): *Limax lombricoides* Morelet, 1845 *partim*; *Agriolimax maltzani* Simroth, 1885; *Deroceras maltzani* (Simroth, 1885).

Deroceras lombricoides (Morelet, 1845): *Agriolimax immaculatus* Simroth, 1891; *Agriolimax lombricoides* (Morelet, 1845) in Simroth, 1891.

Deroceras hispaniensis Castillejo & Wiktor, 1984.

Deroceras geresiensis Rodríguez, Castillejo & Outeiro, 1989; *Agriolimax lombricoides* (Morelet, 1845) in Simroth, 1891 *partim*.

Furcopenis circularis Castillejo & Mascato, 1987.

Family LIMACIDAE

Lehmannia marginata (Müller, 1774): *Limax arborum* Bouchard-Chantereaux, 1837.

Lehmannia valentiana (Férussac, 1823): *Limax poirieri* Mabilie, 1883.

Limax maximus Linné, 1758: *Limax cinereus* Müller, 1774; *Limax sylvaticus* Draparnaud, 1805; *Limax bocagei* Castro, 1873.

Limax flavus Linné, 1758: *Limax variegatus* Draparnaud, 1801; *Limax companyoi* Bourguignat, 1863; *Limax baeticus* Mabilie, 1868.

Superfamily ZONITOIDEA

Family MILACIDAE

Milax gagates (Draparnaud, 1801): *Milax atratus* Mabilie, 1868; *Amalia parryi* Collinge, 1895.

Family PARMACELLIDAE

Parmacella valencienni Webb & Van Beneden, 1836

Superfamily ARIONOIDEA

Family ARIONIDAE

Geomalacus maculosus Allman, 1843: *Geomalacus grandis* Simroth, 1893

Geomalacus anguiformis (Morelet, 1845): *Geomalacus squammantinus* (Morelet, 1845), *Geomalacus viridis* (Morelet, 1845)

Geomalacus oliveirae Simroth, 1891

Arion ater (Linné, 1758): *Arion ater* Morelet, 1845 var. ϵ (non Linné, 1758); *Arion sulcatus* Morelet, 1845) (non Pollonera, 1889); *Arion bocagei* Simroth, 1888.

Arion lusitanicus Mabilie, 1868: *Arion rufus* Morelet, 1845 var. α , Γ , δ (non Linné, 1758).

Arion nobrei Pollonera, 1889: *Arion timidus* Morelet, 1845 (non Simroth, 1891); *Baudonia timida* (Morelet, 1845); *Baudonia montana* Mabilie, 1868; *Arion sulcatus* Pollonera, 1889 (non Morelet, 1845); *Arion lusitanicus* Simroth, 1891 *partim* (non Mabilie, 1868)

Arion fuliginus Moleret, 1845; *Arion fuscatus* Morelet, 1845 var. α (non Férussac, 1819); *Arion pascalianus* Mabilie, 1868 (non Simroth, 1891); *Arion dasilvae* Pollonera, 1887; *Arion lusitanicus* Simroth, 1891 *partim* (non Mabilie, 1868).

Arion hispanicus Simroth, 1886

Arion intermedius Normand, 1852: *Geomalacus intermedius* (Normand) in Mabilie, 1868; *Arion mollerii* Pollonera, 1889; *Arion pascalianus* Simroth, 1891 (non Mabilie, 1868); *Arion minimus* Simroth, 1891; *Arion hessei* Simroth, 1893.

Superfamily TESTACELLOIDEA

Family TESTACELLIDAE

Testacella maugei (Férussac, 1819): *Testacella canariensis* Grateloup, 1855; *Testacella deshayesii* Michaud, 1855; *Testacella aurigaster* Watson, 1915.

KEY TO PORTUGUESE SLUGS

Note: Measurements refer to extended length of live adult slugs, and are based on Portuguese material; larger sizes have been reported elsewhere, especially in the *Arion* species.

- 1a: Slugs with external shell at tail tip (F. Testacellidae)
Testacella maugei (Fig. 1A, 1F, 8D, 10I)
 1b: Slugs without external shell 2
 2a: Pneumostome anterior to midpoint of mantle. Hind-end of body rounded. Without dorsal keel (F. Arionidae) 16

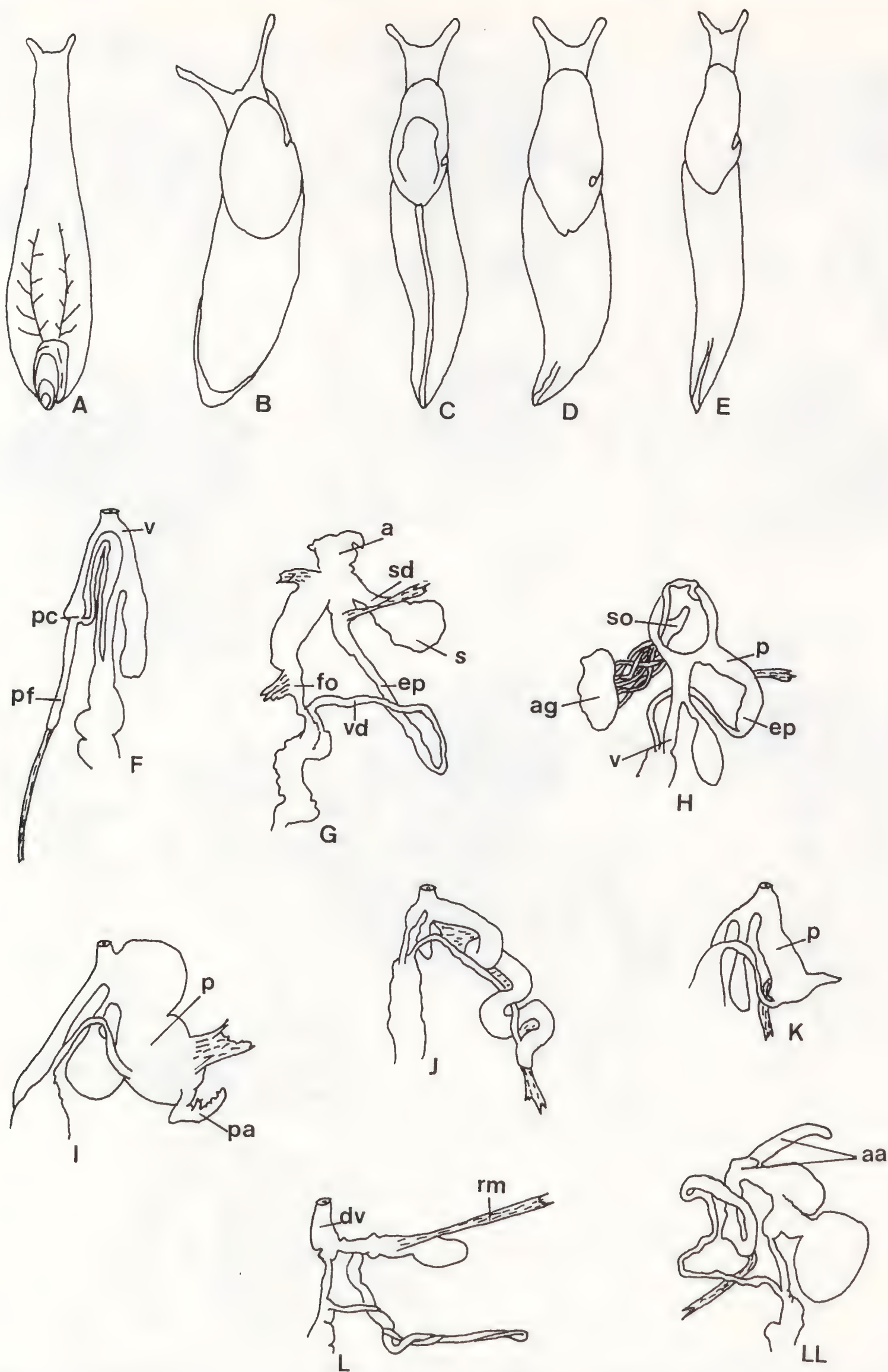


Fig. 1. External morphology and distal genitalia of Portuguese slugs. Anatomical nomenclature used: a: atrium; aa: accessory appendix; ag: accessory gland; dv: vaginal diverticulum; ep: epiphallus; fo: free oviduct; p: penis; pa: penial appendix; pc: penial caecum; pf: penial flagellum; rm: retractor muscle; s: spermatheca; sd: spermatheca duct; so: stimulator organ; v: vagina; vd: vas deferens. A,F: *Testacella*; B,G: *Arion*; C,H: *Milax*; D,I: *Deroceras*; E,K: *Lehmannia*; J: *Limax*; L: *Geomalacus*; LL: *Parmacella*.

- 2b: Pneumostome posterior to midpoint of mantle. Hind-end of body pointed. Dorsal keel present at hind-end of body 3
- 3a: A long dorsal keel, usually reaching hind edge of mantle 4
- 3b: A short dorsal keel, not reaching mantle 5



Fig. 2. Distal genitalia of Portuguese slugs. A: *D. laeve*; B: *D. panormitanum*; C: *D. reticulatum*; D: stimulator inside the penis in *D. reticulatum*; E *D. nitidum*; F: stimulator *in situ* in *D. nitidum*; G: superior and inferior views of the evaginated stimulator in *D. lombricoides*. ov: ovotestis; p: penis; pa: penial appendix; rm: retractor muscle; s: spermatheca; so: stimulator organ; vd: vas deferent.

4a: Brown with black spots. Genital atrium with two unequal appendices. Spermatheca duct with a large swelling near its junction with the atrium

Parmacella valencienni (Fig. 1LL, 9I)

4b: Black or dark grey, without spots. Atrium without appendices. Spermatheca duct without swelling near. Stimulator thin, gradually narrowing towards its end, its inner walls smooth with several papillae near free end. ***Milax gagates*** (Fig. 1C, 1H, 4E, 10B)

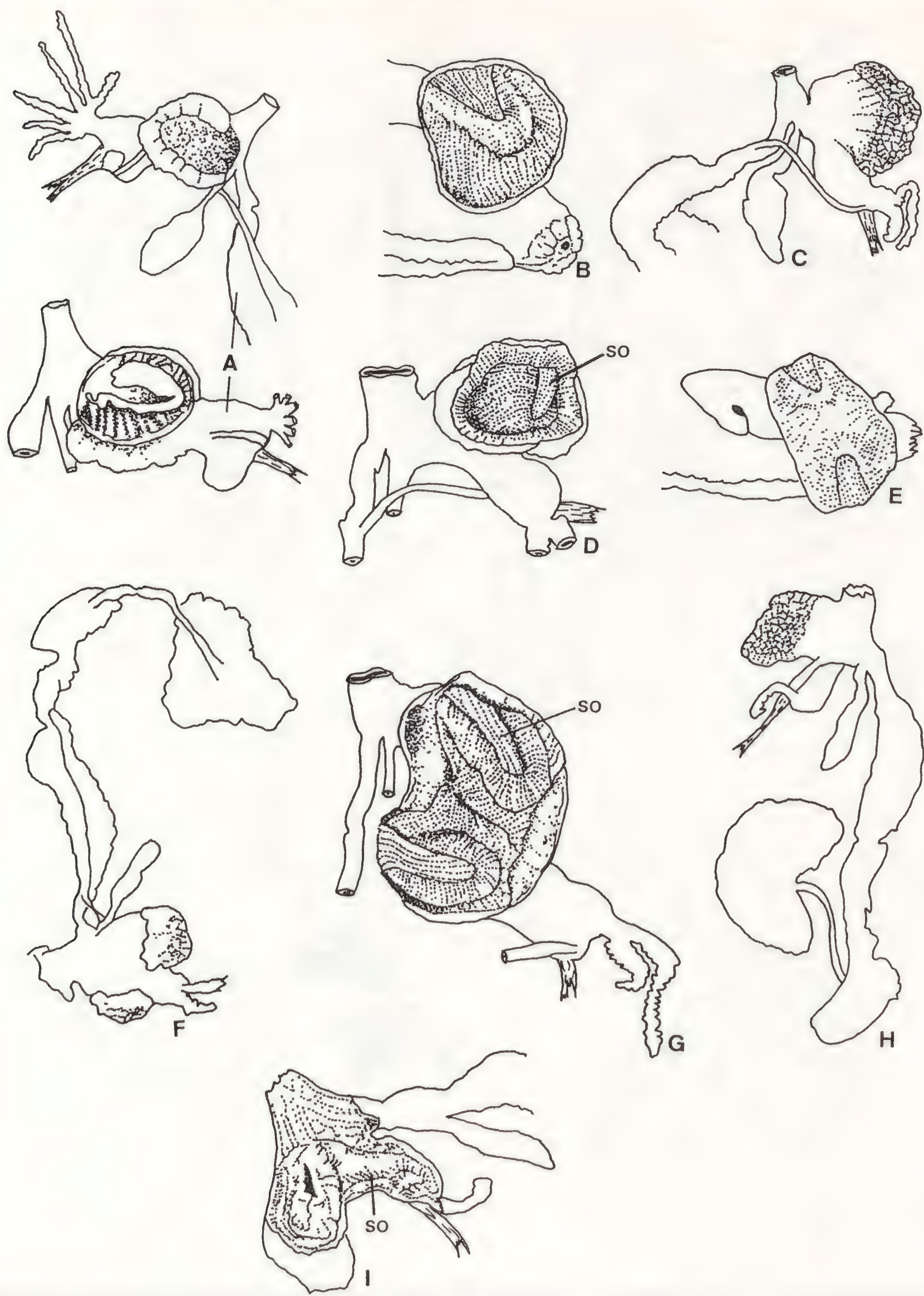


Fig. 3. Distal genitalia of Portuguese slugs. A: *D. lombricoides* and stimulator *in situ*; B-D: *D. hispaniensis*; B: specimens with the evaginated stimulator; D: stimulator *in situ*; E-G: *D. geresiensis*; E: specimen with the distal penis evaginated; G: stimulator *in situ*; H-I: genitalia and stimulator inside the penis in *F. circularis*. so: stimulator.

- 5a: Dorsal keel short and obscure. Not banded (Agriolimacidae) 6
5b: Dorsal keel longer (about 1/4 of body length). May be banded (Limacidae) 13
6a: Stimulator inside penis (***Deroceras***, Fig. 1D, 1I) 7
6b: Stimulator inside an accessory organ which joins the penis
Furcopenis circularis (Fig. 3H–I, 9F)

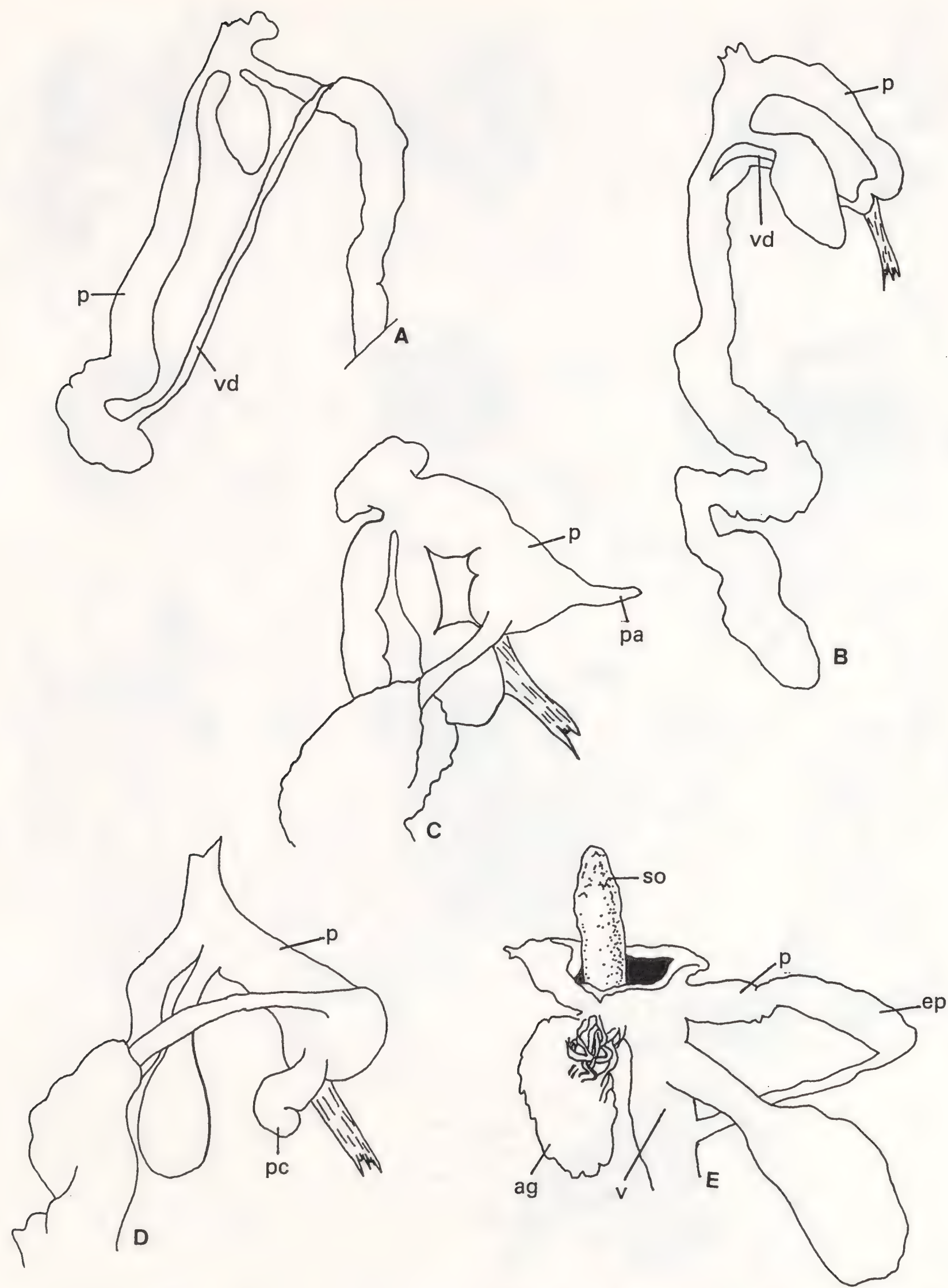


Fig. 4. Distal genitalia of Portuguese slugs. A: *L. maximus*; B: *L. flavus*; C: *L. marginata*; D: *L. valentiana*; E. stimulator organ inside of atrium in *M. gagates*. ag: accessory gland; ep: epiphallus; p: penis; pa: penial appendix; so: stimulator organ; v: vagina; vd: vas deferens.

- 7a: Intestine without caecum 8
- 7b: Intestine with caecum 9
- 8a: Body and mantle pale to very dark brown. Sole pale brown. Penis (if present) with a distal globular appendix, and with no proximal glandular swelling

Deroceras laeve (Fig. 2A, 9B)
- 8b: Body dark brownish grey and translucent. Penis with a proximal glandular swelling and

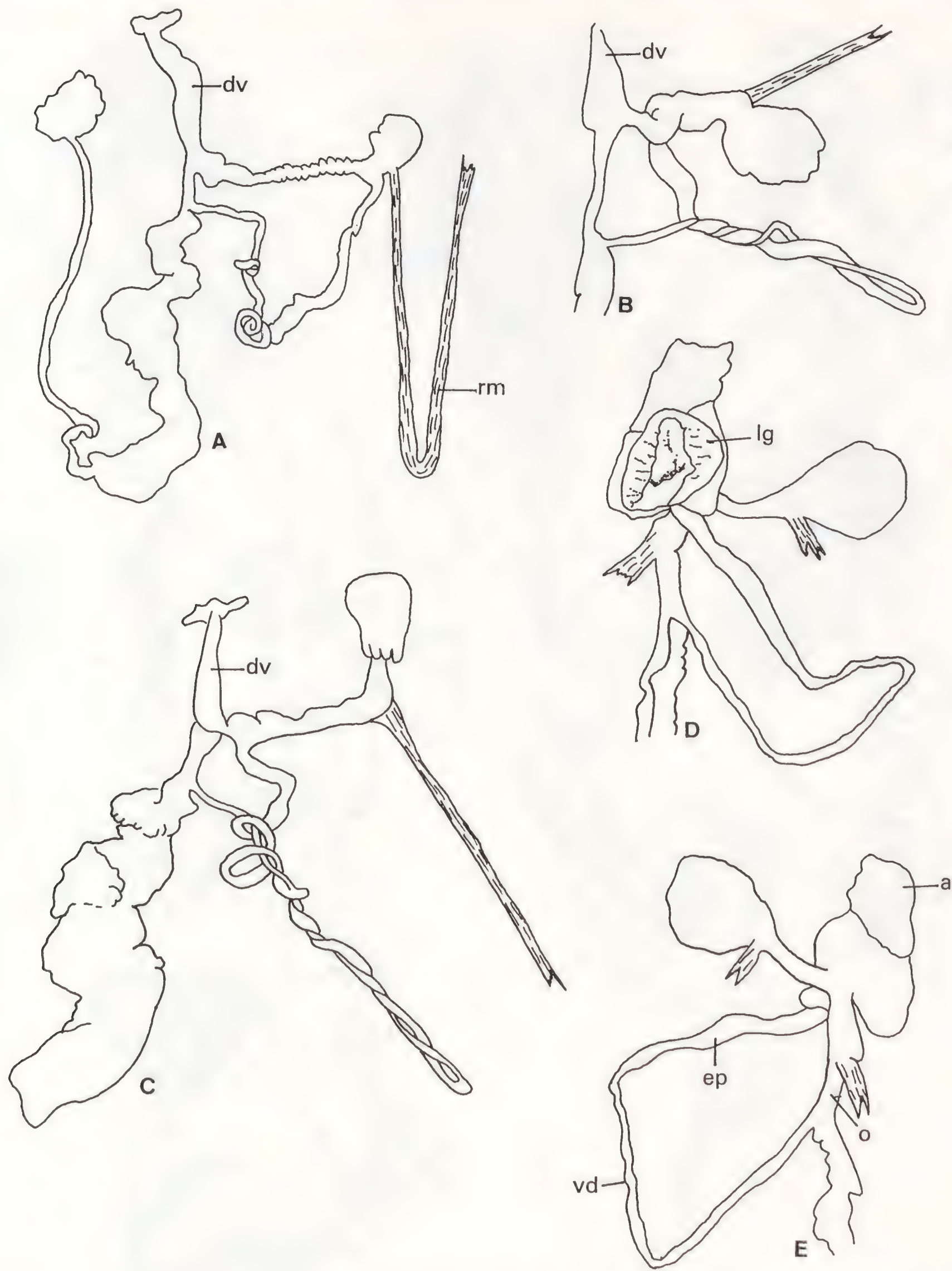


Fig. 5. Distal genitalia of Portuguese slugs. A: *G. maculosus*; B: *G. oliveirae*; C: *G. anguiformis*; D-E: ligula inside proximal atrium and copulatory organs in *A. ater*. a: atrium; dv: vaginal diverticulum; ep: epiphallus; lg: ligula; o: oviduct; rm: retractor muscle; vd: vas deferens.

- with two distal appendices in the form of horseshoe, between which arises an appendage with 4–5 finger-like lobes ***Deroceras panormitanum*** (Fig. 2B, 9C)
- 9a: Penis with subterminal caecum (adjacent to terminal appendix) 10
- 9b: Body usually, but not always, with a darker flecking. Penis without subterminal caecum
Deroceras reticulatum (Fig. 2C–D, 9D)
- 10a: Stimulator conical ***Deroceras nitidum*** (Fig. 2E–F, 9E)
- 10b: Stimulator flat 11

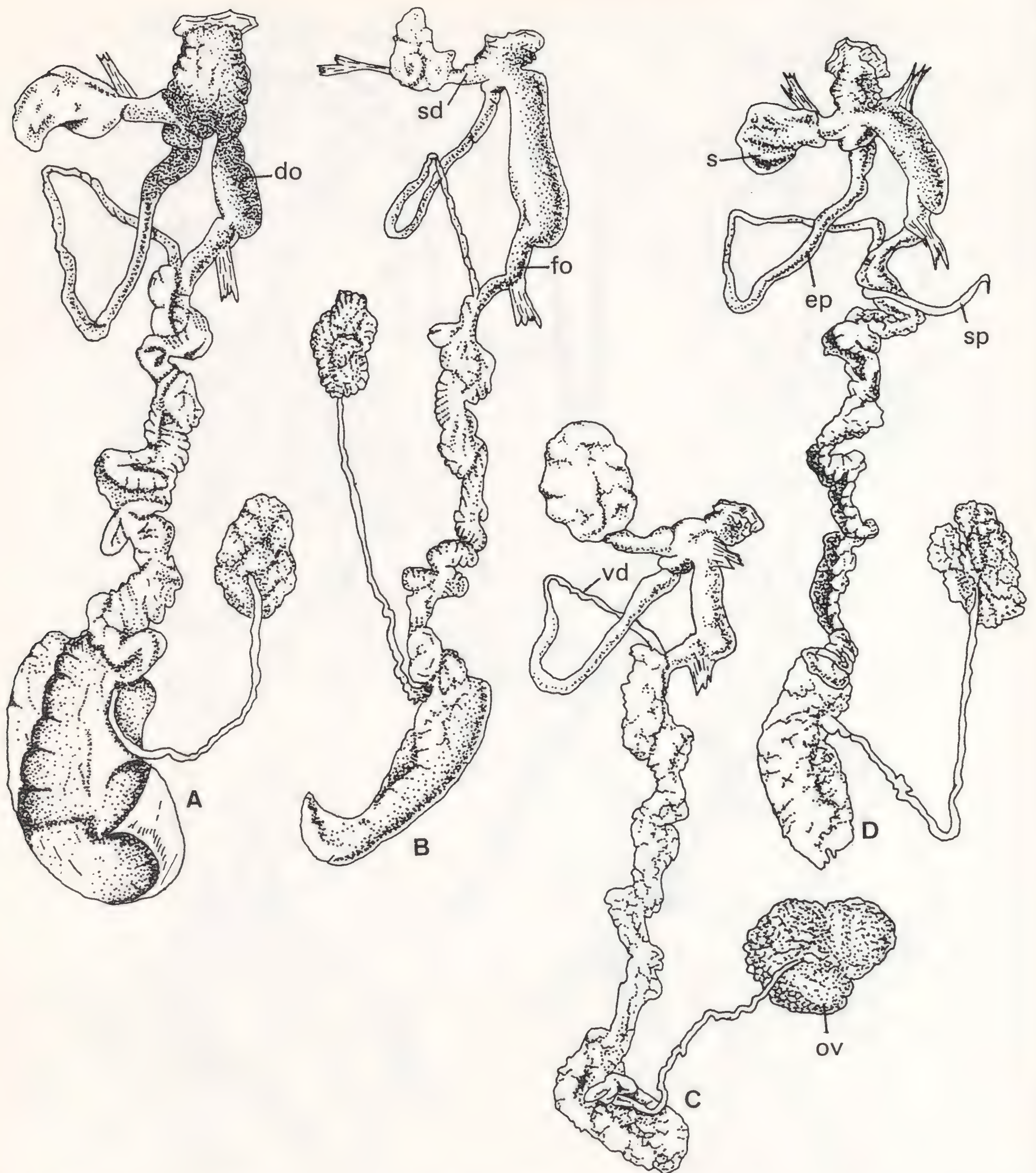


Fig. 6. Distal genitalia of Portuguese slugs. A: *A. nobrei*; B-C: *A. fuligineus*; D: *A. lusitanicus*. do: distal oviduct; ep: epiphallus; fo: free oviduct; s: spermatheca; sd: spermatheca duct; sp: spermatophore; vd: vas deferens.

- 11a: Penis with a single stimulator 12
- 11b: Penis with two stimulators *Deroceras geresiensis* (Fig. 3E-G, 9F)
- 12a: Penis with 4-6 branches to appendix. Stimulator in form of a horseshoe or a flat fold
Deroceras lombricoides (Fig. 2G-H, 3A, 9E)
- 12b: Penis with 2-3 appendices. Stimulator is membranous and annular
Deroceras hispaniensis (Fig. 3B-D, 9E)
- 13a: Body with two or more dark bands or rows of dark spots. Penis with a terminal
flagellum and a V-shaped fold inside (G. *Lehmannia*, Fig. 1E, IK) 14

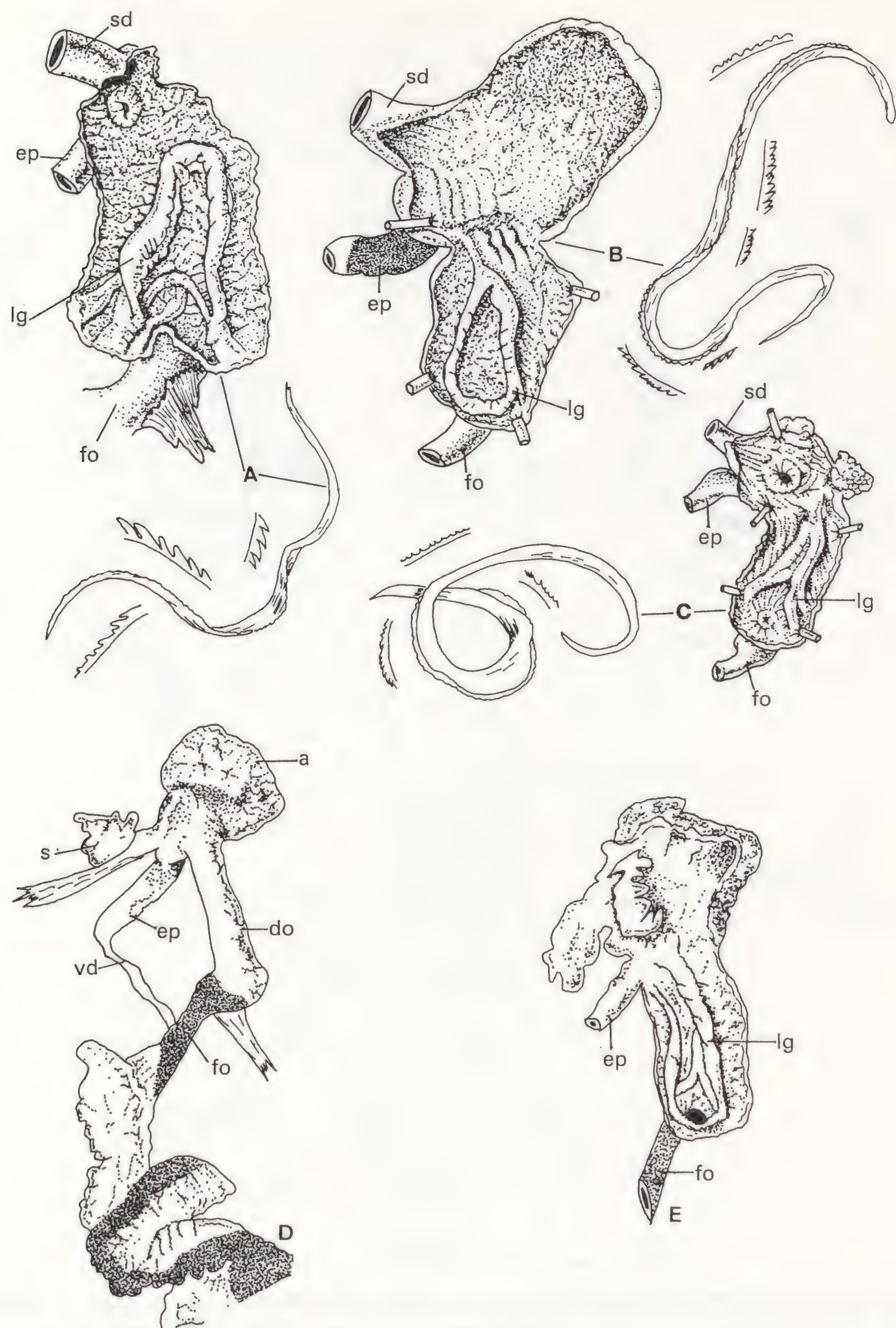


Fig. 7. Distal genitalia of Portuguese slugs. A: ligula and spermatophore in *A. lusitanicus*; B: ligula and spermatophore in *A. nobrei*; C: ligula and spermatophore in *A. fuligineus*; D-E: copulatory organs and ligula in *D. hispanicus*. a: atrium; do: distal oviduct; ep: epiphallus; fo: free oviduct; lg: ligula; s: spermatheca; sd: spermatheca duct; vd: vas deferens.

- 13b: Body lacking bands, but often spotted. Penis without terminal flagellum and with a longitudinal fold inside (G. *Limax*, Fig. IJ) 15
- 14a: Greyish, with two lateral bands on body and mantle. Watery mucus. Penial appendix pointed, situated opposite insertion of the genital retractor muscle
Lehmannia marginata (Fig. 4C, 9G)



Fig. 8. Distal genitalia of Portuguese slugs. A-C: *A. intermedius*; D: *T. maugei*.

- 14b: Penial appendix blunt, next to insertion of genital retractor muscle *Lehmannia valentiana* (Fig. 4D, 9H)
- 15a: Large slug (100–120 mm). Pale brown to grey with two or three darker longitudinal bands on body and with spots or blotches on mantle. Sole pale. Body mucus colourless. Penis less than half length of body. Intestine without caecum. Spermatheca opening into base of atrium *Limax maximus* (Fig. 4A, 9I)
- 15b: Medium slug (70–100 mm). Body pale with smaller dark blotches or vice versa. Body mucus yellow. Penis longer than half body length. Intestine with caecum. Spermatheca opening into oviduct *Limax flavus* (Fig. 4B, 10A)

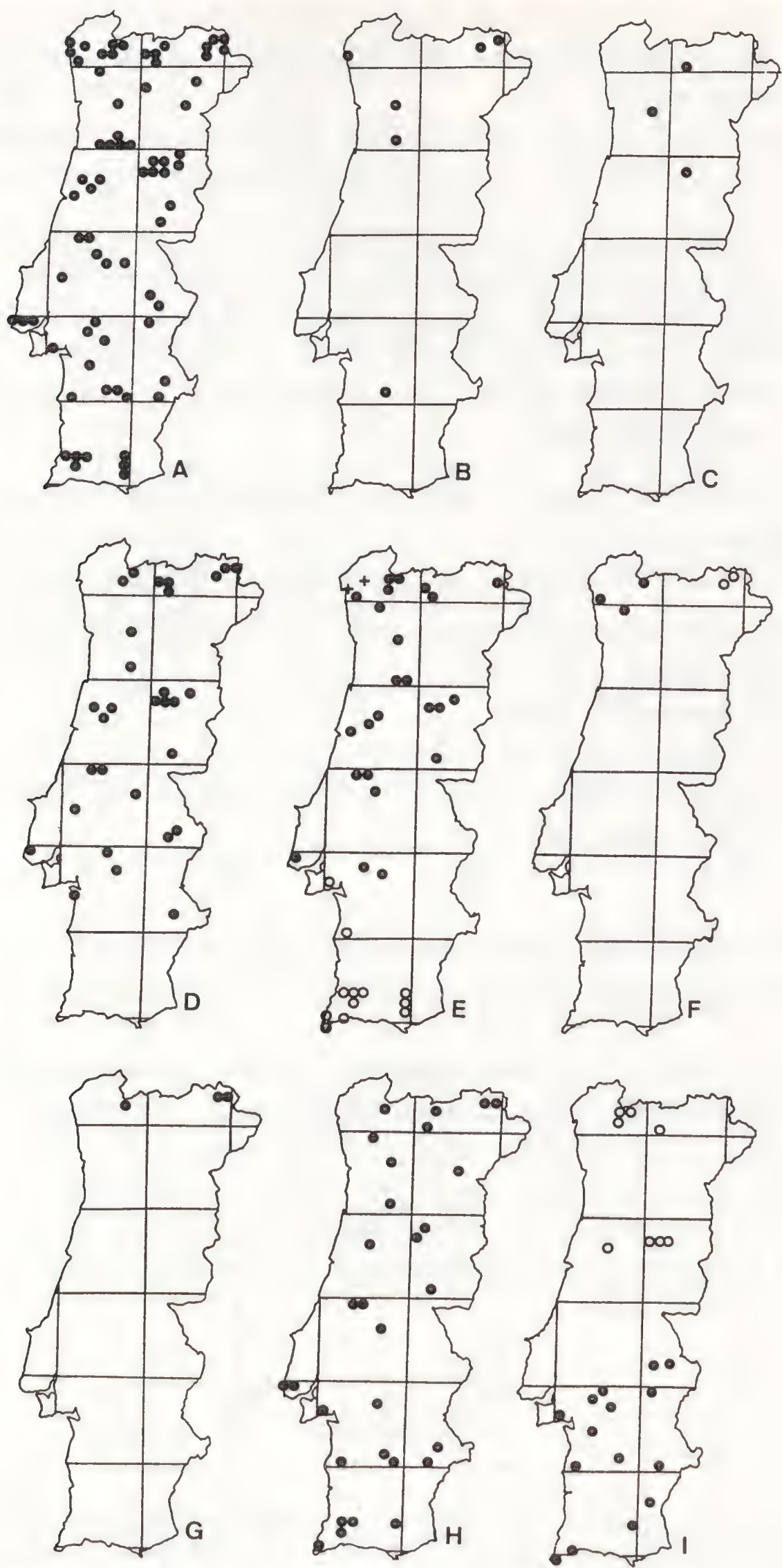


Fig. 9. Distribution maps. A: Sites studied; B: *D. laeve*; C: *D. panormitanum*; D: *D. reticulatum*; E: ○ *D. nitidum*, ● *D. lombricoides*, + *D. hispaniensis*; F: ● *D. geresiensis*, ○ *F. circularis*; G: *L. marginata*; H: *L. valentiana*; I: ○ *L. maximus*, ● *P. valencienni*.

- 16a: Body and mantle unicolorous, or with a pair longitudinal dark bands (G. *Arion*, Fig. 1B, 1G) 17
- 16b: Body and mantle dark with pale spots, or with four longitudinal bands (G. *Geomalacus*, Fig 1L) 22
- 17a: Without ligula. Small (less than 30 mm); may appear ‘prickly’ at rear when contracted due to conical tubercles *Arion intermedius* (Fig. 8A–C, 10H)
- 17b: With ligula in atrium or oviduct. Adults larger (30–150 mm). Not ‘prickly’ 18

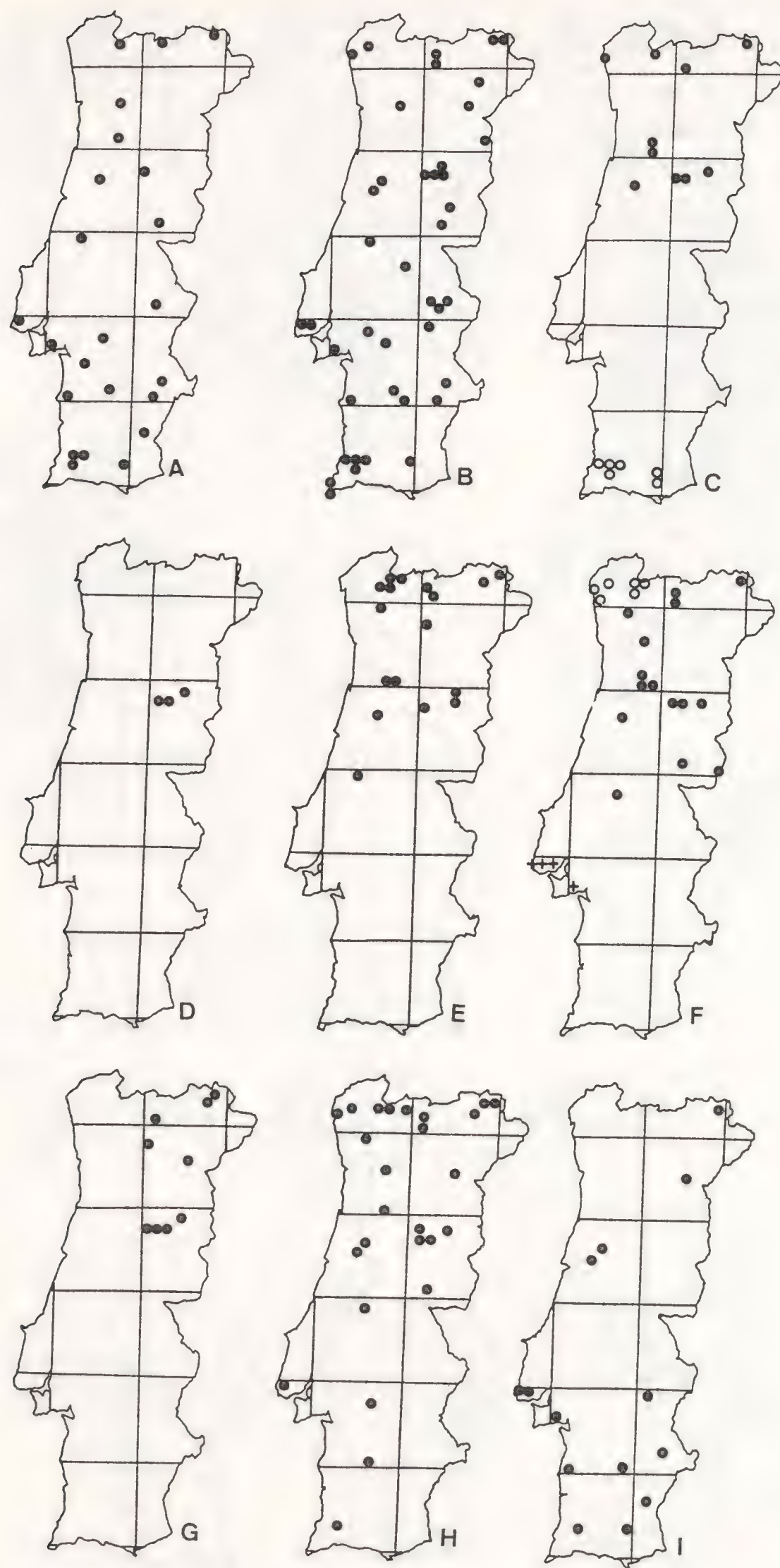


Fig. 10. Distribution maps. A: *L. flavus*; B: *M. gagates*; C: ● *G. maculosus*, ○ *G. anguiformis*; D: *G. oliveirae*; E: *A. ater*; F: + *A. lusitanicus*, ● *A. nobrei*, ○ *A. fuliginus*; G: *A. hispanicus*; H: *A. intermedius*; I: *T. maugei*.

- 18a: Ligula inside atrium. Very large (over 100 mm when adult). Usually uniform grey or black when mature ***Arion ater*** (Fig. 4D–E, 10E)
 18b: Ligula inside oviduct. Usually less than 100 mm 19
 19a: Adults 30–40 mm long. With two dark longitudinal bands. Genitalia whitish, with or without the oviduct, lower atrium and oviductal portion of sperмовiduct pigmented blackish ***Arion hispanicus*** (Fig. 7D–E, 10G)
 19b: Adults longer than 70 mm. Uniform colour or with dark bands 20

- 20a: Usually without bands, or with bands which do not reach mantle. Distal oviduct, distal part of epiphallus, proximal atrium and ligula with black pigment. 90–100 mm long. ...
Arion nobrei (Fig. 6A, 7B, 10F)
- 20b: With two longitudinal bands which extend onto mantle. Genitalia with or without the base of epiphallus and oviduct greyish or purplish. 70–90 mm. 21
- 21a: Brown yellowish body with two dark bands. Lateral zone of the sole darker than central part. Epiphallus and vas deferens of equal length. Spermatophore cylindrical, without crest. Adults usually less than 80 mm *Arion lusitanicus* (Fig. 4D, 7A, 10F)
- 21b: Body orange, orange-brown or dark brown. Sole white. Vas deferens shorter than epiphallus. Spermatophore cylindrical, with crest. 90 mm long when mature.
Arion fulgineus (Fig. 6B-C, 7C, 10F)
- 22a: Adults 80–120 mm. Body with white or yellowish spots. Atrial diverticulum long, wide near its junction with atrium *Geomalacus maculosus* (Fig. 5A, 10C)
- 22b: Adults less than 70 mm. Body with four dark bands. Atrial diverticulum short ... 23
- 23a: Spermatheca duct large and in “L” shape with the genital retractor muscle inserted at the angle of the “L” (well removed from spermatheca). Spermatheca and spermatheca duct white *Geomalacus anguiformis* (Fig. 5C, 10C)
- 23b: Spermatheca duct short, thick and straight. Genital retractor inserted near spermatheca. Spermatheca and spermatheca duct darkly pigmented
Geomalacus oliveirae (Fig. 5B, 10D)

NOTES

D. panormitanum: There are different opinions about the name of this taxon, and we do not attempt to resolve the question here. We have studied descriptions and we think only one species is involved.

D. nitidum, *D. lombricoides* and *D. hispaniensis*: see Castillejo *et al.* (1989).

M. gagates: Species similar to *M. nigricans* and often mistaken for it. The most reliable distinctive feature is the stimulator, which is thin and with short papillae at the tip in *M. gagates* while in *M. nigricans* it is wider with large papillae at the base.

G. maculosus, *G. oliveirae* and *G. anguiformis*: see Rodríguez *et al.* (1993).

A. ater, *A. lusitanicus*, *A. nobrei* and *A. fulgineus*: see Castillejo & Rodríguez (in press).

REFERENCES

- ADAM, W. 1960. *Faune de Belgique. Mollusques terrestres et dulcicole*. Inst. R. Scien. Nat. Belgique, 402 pp., Bruxelles.
- CAMERON, R. A. D., EVERS HAM, B. & JACKSON, N. 1983. A field key to the slugs of the British Isles. *Field Stud.* **5**: 807–824.
- CASTILLEJO, J., DIAZ COSIN, D. J., CALVIN, E. B. & MASCATO, R. 1984. *Deroceras lombricoides* (Morelet, 1845) (*Gastropoda, Pulmonata, Agriolimacidae*) in the Braga mountains and the Serra de Estrela (Portugal). *Cienc. Biol.* **5**: 117–129.
- CASTILLEJO, J., RODRIGUEZ, T. & OUTEIRO, A. 1989. Portuguese slugs. II. *Deroceras nitidum* and the *Deroceras lombricoides* group of forms. (*Gastropoda, Pulmonata, Agriolimacidae*). *J. Conch., Lond.* **33**: 233–254.
- CASTILLEJO, J. & RODRIGUEZ, T. (in press). Reseñas históricas sobre el género *Arion* Férussac, 1819 en Portugal. *Graellsia*.
- , (in press). Las especies del género *Arion* Férussac, 1819 en Portugal (*Gastropoda, Pulmonata: Arionidae*). *Graellsia*.
- CAZIOT, E. 1915. La faune terrestre Lusitanienne. *Soc. Lin.* **62**: 43–65.
- COLLINGE, W. E. 1897. Some observations on certain species of *Arion*. *J. Malacol.* **6**: 7–10.
- LESSONA, M. & POLLONERA, C. 1884. *Monografia dei limacidi italiani*. *Mem. R. Acad. Sc. Torino* **35**: 49–128.
- LIKHAREV, I. M. & WIKTOR, A. 1980. *The fauna of Slugs of the USSR and Adjacent Countries (Gastropoda, terrestria nuda)*. Fauna SSSR, Mollyuski III, 3. Leningrad, 438 pp.

- MABILLE, M. J. 1868. Des limaciens européens. *Rev. Mag. Zool. Ser.2* **20**: 129–147.
- MORELET, A. 1845. *Description des mollusques terrestres et fluviatiles du Portugal*. 177 pp., Paris.
- , 1877. *Revision des mollusques terrestres et fluviatiles du Portugal*. 21 pp. Paris.
- NOBRE, A. 1930. *Moluscos terrestres, fluviais e das aguas salobres de Portugal*. Ministerio de Agricultura, Porto, 259 pp.
- , 1941. *Fauna malacologica de Portugal. II. Moluscos terrestres e fluviais*. Coimbra. Coimbra. 277 pp.
- POLLONERA, C. 1887. Specie nuove o mal conosciute di *Arion* europei. *R. Acc. Sc.* **22**: 1–27.
- , 1889. Nuove contribuzioni allo studio degli *Arion* europei, I. Specie portoghesi dell *Arion rufus*. *R. Acc. Sc. Torino*. **24**: 1–20.
- , 1890a. Recensement des *Arionidae* de la Region Paléarctique. *Boll. Mus. Zool. Anat. comp. Torino* **87**(5): 1–40.
- , 1890b. Subsídios para o estudo das especies portuguesas do genero *Arion*. *O Instituto* **37**(2): 238–240.
- , 1890c. A proposito degli *Arion* del Portogallo. Risposta al Dr. Simroth. *Boll. Mus. Zool. Anat. comp. Torino* **80**(5): 1–7.
- QUICK, H. E. 1960. *British slugs (Pulmonata, Testacellidae, Arionidae, Limacidae)*. *Bull. Brit. Mus. (Nat. Hist.) Zool* **6**(3): 105–226.
- RODRIGUEZ, T., CASTILLEJO, J. & OUTEIRO, A. 1989. Morphology and anatomy of *Deroceras geresiensis* n.sp. (*Gastropoda, Pulmonata, Agriolimacidae*) from Iberian Peninsula. *The Veliger* **32**(1): 95–100.
- , ONDINA, P., OUTEIRO, A. & CASTILLEJO, J. 1993. Slugs of Portugal. III. Revision of the Genus *Geomalacus* Allman, 1843 (*Gastropoda: Pulmonata: Arionidae*). *The Veliger* **36**(2): 145–159.
- SEIXAS, M. M. P. 1976. Gasterópodes terrestres de fauna portuguesa. *Bolm. Soc. Port. Cienc. Nat.* **16**: 21–46.
- , 1977. Duas espécies de *Limacidae* (*Gastropoda, Pulmonata*), novas para a fauna portuguesa. *Bolm. Soc. Port. Cienc. Nat.* **17**: 57–61.
- , 1978. Descrição de uma espécie de *Limacidae* (*Gastropoda, Pulmonata*), nova para a fauna portuguesa. *Bolm. Soc. Port. Cienc. Nat.* **18**: 5–6.
- SILVA, A. L. DA, 1867. Molluscos terrestres e fluviais de Portugal. *J. Scien. Math. Phy. Nat.*, 155–156.
- , DA, & CASTRO, J. DA, 1873. Mollusques terrestres et fluviatiles du Portugal. Espèces nouvelles ou peu connus. *J. Sc. Math. Phys. Nat.* **15**: 241–246.
- SIMROTH, H. 1886. Wetere Mitteilungen über plaerktische Nacktschnecken. *Jahrb. Dtsch. Malak. Ges.* **13**: 16–34.
- , 1888. Über die azonisch-portuguese Nacktschneckenfauna und ihre Beziehungen. *Zool. Anz.*, **11**: 66–70, 86–90.
- , 1889. Beiträge zur kenntniss der Nacktschnecken. *Nach. Deuts. Malak. Ges.* **11**: 177–186.
- , 1889. Über einige kleinasiatische Nacktschnecken. *Sitzungsber. naturforsch. Ges. Leipzig.*, **24–25**: 35–38.
- , 1891. Die nacktschnecken der portugiesischazorischen fauna in ihrem Verhältniss zu denen der paläarktischen region überhaupt. *Nova Acta*, 425 pp.
- , 1893. Beiträge zur Kenntniss der portugiesischen und der ostafrikanischen Nacktschnecken-fauna. *Abh. senckenb. naturforsch. Ges.* **18**: 289–309.
- TAYLOR, J. W. 1907. *Monograph of the land and freshwater mollusca of the British Isles. Parts. 13, 14, 22, 23 & 24*. 640 pp., Leeds.
- WIKTOR, A. 1973. *Die Nacktschnecken Polens. Arionidae, Milacidae, Limacidae. (Gastropoda, Stylommatophora)*. 179 pp, Warszawa.
- , 1983. *The slugs of Bulgaria (Arionidae, Milacidae, Limacidae, Agriolimacidae, Gastropoda, Stylommatophora)*. *Ann. Zool.* **37**(3): 71–206.

COMMUNICATIONS

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Applications published in the Bulletin of Zoological Nomenclature The following application was published on 25 March 1993 in Vol. 50, Part 1 of the *Bulletin of Zoological Nomenclature*. Comment or advice on these Applications is invited for publication in the *Bulletin* and should be sent to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

Case 2838

***Pleurobranchus forskalii* Rüppell & Leuckart, [1828] and *P. testudinarius* Cantraine, 1835 (Mollusca, Gastropoda): proposed conservation of the specific names**

W. B. Rudman

The Australian Museum, P.O. Box A285, Sydney South, New South Wales, Australia 2000

Abstract. The purpose of this application is to conserve the specific names of the pleurobranch opisthobranch molluscs *Pleurobranchus forskalii* Rüppell & Leuckart, [1828] and *P. testudinarius* Cantraine, 1835. The latter name is threatened by the senior objective synonym *Pleurobranchus forskahli* Delle Chiaje, 1822. Additionally, it is shown that the name ‘*Lepus marinus*’ mentioned by Forsskål (1776) and others is a vernacular.

Opinions published in the Bulletin of Zoological Nomenclature

The following Opinions were published on 25 March 1993 in Vol. 50, Part 1 of the *Bulletin of Zoological Nomenclature*.

Opinion 1699. *Conus fulmen* Reeve, 1843 (Mollusca, Gastropoda): specific name conserved, and *Conus berghausi* Michelotti, 1847 given precedence over *C. demissus* Philippi, 1836

Opinion 1700. *Laecochlis* Dunker & Metzger, 1874 (Mollusca, Gastropoda): conserved as the correct spelling

The following Application was published on 30 June 1993 in Vol. 50, Part 2 of the *Bulletin of Zoological Nomenclature*.

Case 2820

***Turbo politus* Linnaeus, 1758 (currently *Melanella polita*; Mollusca, Gastropoda): proposed conservation of usage of the specific name, so conserving the specific name of *Buccinum acicula* Müller, 1774 (currently *Cecilioides acicula*)**

Anders Warén

Naturhistoriska Riksmuseet, Sektionen för Evertebratzologi, Box 50007, S-10405 Stockholm, Sweden

Edmund Gittenberger

Nationaal Natuurhistorisch Museum, Mollusca, Postbus 9517, NL 2300 RA Leiden, The Netherlands

Abstract. The purpose of this application is to conserve the current universal understanding and usage of the specific name of the European prosobranch mollusc *Turbo politus* Linnaeus, 1758 (family EULIMIDAE Philippi, 1853) for which a neotype has been designated. Recently discovered syntypes of *T. politus* are conspecific with *Buccinum acicula* Müller, 1774, the type species of *Cecilioides* Férussac, 1814 (Pulmonata, family FERUSSACIIDAE Bourguignat, 1883). *C. acicula* is found around the Mediterranean and in western Europe, and has been introduced into the eastern U.S.A. and Bermuda. Both the names *Cecilioides* and *B. acicula* have been placed on Official Lists (Opinion 335; March 1955).

Opinions published in the Bulletin of Zoological Nomenclature

The following Opinions were published on 30 June 1993 in Vol. 50, Part 2 of the *Bulletin of Zoological Nomenclature*. Copies of these Opinions can be obtained free of charge by writing to the Executive Secretary, I.C.Z.N., c/o The Natural History Museum, Cromwell Road, London SW7 5BD, U.K.

Opinion 1718. *Balea* Gray, 1824 (Mollusca, Gastropoda): conserved.

Opinion 1719. *Xeromunda* Monterosato, 1892 (Mollusca, Gastropoda): *Helix candiota* Pfeiffer, 1849 designated as the type species.

Opinion 1720. *Cycloceras* M’Coy, 1844 (Mollusca, Nautiloidea): *C. laevigatum* M’Coy, 1844 designated as the type species, and a neotype designated for *C. laevigatum*.

Opinion 1721. BELEMNITIDAE Owen, 1838 (Mollusca, Coleoidea): ruled to be unavailable; *Belemnites* Lamarck, 1799 and *B. paxillosa* Lamarck, 1801 suppressed.

ANODONTA CYGNEA (L.) IN SOFT WATER

Anodonta cygnea (L.) is classed as a calciphile species (Boycott, *J. Anim. Ecol.* **5** (1936) p. 154) requiring a moderate amount of calcium in the water (Ellis, *British Freshwater Bivalve Mollusca*, Academic Press, London (1978) p. 23). Its occurrence in Lough Graney (R567 907), a soft-water lake in County Clare (Irish vice-comital division number 9), is therefore of some interest. This lake lies at an altitude of 49 m in an area of Silurian and Old Red Sandstone strata where the soils are principally gleys, except for the western shore where brown podzolics predominate. It is a relatively small lake (370 ha) with a maximum length of 4.3 km, of moderate depth (maximum 19 m) and the water is at times markedly coloured (e.g. 60 Hazen units) with low transparency (e.g. Secchi disc 1.5–2.0 m). The lake type could be classified as naturally oligotrophic but shows signs of artificial enrichment and it supports a variety of so-called coarse fish species with good stocks of pike (*Esox lucius*) and bream (*Abramis brama*).

A. cygnea was found in fairly large numbers in sand and silt substrata in the littoral area of the lake. The umbones of all specimens examined, including young individuals, showed considerable erosion and the rugae were consequently absent; denudation of the periostracum in some living individuals was as high as 60% of valve surface. The shells were colonised, to some extent, by filamentous algal growths on the unburied posterior end and *Ancylus fluviatilis* Müll., which is classed as a soft-water species by Macan (*Scient. Publ. Freshwat. biol. Ass.*, **13** (1977) p. 42.), was found attached to some shells. This pulmonate is more common in harder waters and although it has a minimum calcium requirement (Maitland, *Proc. malac. Soc. Lond.* **36** (1965) pp. 339–347.) will often occur in soft water where the type is small and relatively thin-shelled. The prosobranch *Potamopyrgus jenkinsi* (Smith) also occurred. The specimens of *A. cygnea*, despite exhibiting surface decortication, showed neither apparent signs of stunting (specimens ~100 mm in length recorded) nor shell thinning.

The natural chemical characteristics of the Lough Graney site (Flanagan & Toner, *A Preliminary Survey of Irish Lakes*, An Foras Forbartha, Dublin (1975) pp. 86–88) can be compared with that of two other lakes, Lough Derg (Flanagan & Toner, *op. cit.* p. 53) and Lough Derravaragh (Flanagan & Toner, *op. cit.* p. 60), both of which are also in the Shannon Catchment and which contain *A. cygnea* populations:

Lake	pH	Alkalinity (mg/l CaCO ₃)	Hardness (mg/l CaCO ₃)
Graney	6.7–7.5	20–35	50–60
Derg	7.8–8.3	190–205	205–220
Derravaragh	7.9–8.3	160–200	185–245

The chemical characteristics of the site resemble more that in which *Margaritifera margaritifera* (L.), another unionacean species which is almost totally restricted to soft water but which is found in some hard-water rivers in Ireland (Lucey, *J. Conch., Lond.* **34** (1993) p. 309), typically occurs. *A. cygnea* and *M. margaritifera* have, however, been found together at one Irish river site (Lucey, *op. cit.* p. 304) where the range in pH, alkalinity and hardness was 7.4–8.4, 68–144 (mg/l CaCO₃) and 76–168 (mg/l CaCO₃) respectively. It would appear that with regard to the Unionacea in Ireland the labels 'strictly calcicole' and 'strictly calcifuge' do not apply.

John Lucey
Environmental Research Unit, Regional Water Laboratory, Kilkenny
and
Fiona B. Devery
Cumberland Terrace, Emmet Street, Birr, County Offaly, Ireland

THEBA PISANA (MÜLLER) NOW WIDESPREAD ALONG PART OF THE NORTH CORNISH COAST

Investigation of the sandy bays between Pentire Point (National grid ref. SW9280) and Cligga Head (SW7353) during April 1993, has disclosed further colonies of *T. pisana* at Polzeath, Daymer Bay, Rock, Trevone, Harlyn Bay, Porthcothan, Mawgan Porth, Holywell and Perranporth. In addition one live snail was found at Crantock Beach.

The only published localities in England, where the species still occurs, are all in Cornwall: St Ives and Crantock (Turk, S. M., *J. Conch., Lond.* (1966) **26**, pp. 19–25; Humphreys, J., *J. Conch., Lond.* (1976) **29**, pp. 93–106) and Treyarnon and Constantine Bays (Humphreys, J., Stephens, B. D. & Turk, S. M., *J. Conch., Lond.* (1982) **31** p. 73). However, in 1991, Peter Freeman noted 'dense populations' at Trevone and Harlyn Bay (*in litt.* to Stella Turk).

The St Ives colony, though small and very restricted by human pressure, is still extant; the colony at Treyarnon

COMMUNICATIONS

and Constantine Bays has now extended further up the coast into Booby's Bay and about 0.5 km inland along the lanes; no sightings have been made at Crantock for at least the last eighty years.

The colonies at Trevone, Harlyn Bay and Holywell are extensive (at least 0.25 km × 0.25 km) and, in many parts, densely populated, with thousands of young snails to be found on a wide variety of plants or, occasionally, crawling over the sand. Those at Polzeath, Daymer Bay, Rock, Porthcothan and Perranporth are smaller, but with large numbers of snails; only a small number is present at Mawgan Porth. In a number of sites the species is established in the fenced-off dune reclamation area. Full details of the present extent of each colony have been deposited at the Cornish Biological Records Unit, Trevithick Centre, Trevenon Rd., Pool, Cornwall TR15 3PL.

Plants most favoured are *Beta vulgaris* ssp. *maritima*, *Raphanus raphanistrum* ssp. *maritimus* and other large crucifers, *Smyrnum olusatrum*, and where present, *Sonchus oleraceus*. Some of these show damage, much of which is due to the quantity of mucus and faeces deposited on the leaves. The following list of some of the plants on which the snails have been found indicates the variety of habitats that they occupy. It also demonstrates that neither pungency nor irritant hairs or poisonous substances appear to deter the snails: *Allium ampeloprasum* var. *babingtonii*, *Ammophila arenaria*, *Anthyllis vulneraria*, *Arctium minus*, *Arum maculatum*, *Cardaria draba*, *Centranthus ruber*, *Daucus carota*, *Eryngium maritimum*, *Euphorbia paralias*, *E. portlandica*, *Galium aparine*, *Geranium dissectum*, *Hedera helix* ssp. *hibernica*, *Heracleum sphondylium*, *Iris foetidissima*, *I. pseudacorus*, *Lotus corniculatus*, *Malva sylvestris*, *Oenanthe crocata*, *Plantago coronopus*, *P. lanceolata*, *Prunus spinosa*, *Pteridium aquilinum*, *Ranunculus ficaria*, *R. repens*, *Reseda luteola*, *Rumex acetosa*, *R. crispus*, *R. obtusifolius*, *Rubus fruticosus* agg., *Scrophularia auriculata*, *S. scorodonia*, *Senecio vulgaris*, *Taraxacum officinale* agg., *Urtica dioica*.

The dimensions of the colony and the large numbers present in some localities suggest that, even though the species is known to be prolific, the site has been occupied for a number of years. Freeman (*op. cit.*) notes that at Harlyn Bay 'the car park attendant said he could remember dense concentrations over the last ten years or so, particularly on the westerly facing wall of his hut'. It is probable that what the attendant has seen each year are concentrations of *T. pisana* as other species are unlikely to carry out this climbing behaviour in such large numbers during the tourist season. Even so, most of the areas have been visited by naturalists during the last couple of decades and it is unlikely that such striking concentrations would pass unnoticed for very long. A lack of severe weather in recent winters will have aided survival, and a warm, damp spring such as in 1993 affords opportunity for rapid growth — snails have been observed feeding during the day during periods of light rain. This does not, however, explain the increase in range, as most of the colonies are still quite separate.

Dense concentrations of the snails are to be found in the rank vegetation surrounding many of the beach car parks and dispersal may be brought about in, or on, motor vehicles, as holiday makers move from one beach to another. In damp weather the young snails are spread like confetti on parts of the sward at Treyarnon Bay, and could easily stick to wet shoes, or in drier weather be picked up on towels spread in hollows in the dunes. The snails were also found on old black plastic drums, so it is possible that they could climb on to a vehicle parked overnight or in wet weather. In the sites where there is no car park adjoining the beach, cars are sometimes parked there illegally. It is interesting that the single Crantock snail was found in the car park, suggesting that it is perhaps more likely to be a recent import than a remnant of the old colony.

Study of the variety of shell pattern and colouring at the different sites might help to throw light on the relationship of the new colonies one with the other and with the colonies in St Ives and South Wales; this would be of particular interest since the St Ives and Treyarnon Bay colonies are considered likely to be separate introductions (Turk, S. M., *J. Conch.*, Lond (1984) **31** pp. 263–280).

I should like to thank Stella Turk for confirmation of the identification of the species, ideas on, and discussion of, possible dispersal mechanisms and loan of relevant material.

Hazel Meredith
17 Esplanade Rd., Newquay, Cornwall TR7 1QB

OXYLOMA SARSI (ESMARK, 1886) IN FRANCE

The distribution of *Oxyloma sarsi* (= *elegans sensu* Quick) is uncertain owing to confusion with *O. elegans* (Risso, 1826) (= *pfeifferi* Rossmässler, 1835). The two species are very similar externally, though readily distinguishable anatomically. The reproductive system of *Oxyloma sarsi* is quite distinctive: the short spermatheca duct is inserted above a bend in the vagina, whereas in *O. elegans* the spermatheca duct is longer and is inserted towards the base of the (straight) vagina. Drawings of the anatomy of both species are to be found in Kerney & Cameron (1978), *A field guide to the snails of Britain and north-west Europe*. A survey of the taxonomic problem which led to the synonymy above is given by the present author in *Vertigo* (Bulletin de l'Association Française pour l'Etude des Mollusques Continentaux) **1** (1991), 29–35.

Oxyloma sarsi was first recorded in France in 1987. It was found in a number of localities of the départements Marne and Aisne (northern France), where it lives in the mud on the edge of ponds, very close to the water (Stévanovitch, 1991).

Two new sites have now been found in the area of Valenciennes (département Nord):

1. Wasnes-au-Bac, 25 km south-west of Valenciennes (UTM ER1767). Edge of ponds by the river Sensée, April 1992.
2. Landrecies, 30 km south-east of Valenciennes (UTM ER4953). Canal bank, close to the water's edge, April 1992.

The species is probably widespread but overlooked in northern France. Some of the past records of French malacologists working in that area may well refer to *Oxyloma sarsi*, but in the absence of anatomical data this is impossible to ascertain.

The presence of *Oxyloma sarsi* in southern France is more unlikely. Nice (Alpes Maritimes) is the type locality of *Oxyloma elegans*, and specimens of *Oxyloma* from Mediterranean countries belong to that species, which reaches as far south as northern Africa. *Oxyloma sarsi* has so far only been reported from north-west and eastern Europe, though intensive field work with systematic dissection might still change that pattern.

I would like to thank Dr June Chatfield for her help in collecting the specimens.

Colette Stévanovitch
33 rue Marie Aroux, 76000 Rouen, France

BOOK REVIEWS

Atlante delle Conchiglie del Medio Adriatico (Atlas of shells from the central Adriatic sea) by T. Cossignani, V. Cossignani, A. Di Nisio & M. Passamonti. L'Informatore Piceno Ed., Ancona. ISBN 88-86070-00-4, 1992. 40 pp, 417 colour plates. Price It. Lire 65,000.

This very attractively produced hardback, A4 format book is actually an illustrated catalogue of the marine molluscs found in the Italian sector of the mid-Adriatic, rather than an atlas. It includes all littoral and sub-littoral species recorded between 42° 53.45'N and 43° 58'N although the reasons for this delineation are not clear. It does not cover the coast or territorial waters of the former Yugoslavia, although I presume that there will be little difference in the fauna.

The opening sixteen pages include an introduction in 5 languages followed by geographical and biotopic information in parallel columns of Italian and English. This is followed by a comprehensive list in systematic order of the 417 species recorded. The classification follows that of the *Annotated checklist of Mediterranean marine mollusks* by Sabelli, Gianuzzi-savelli & Bedulli, published in 1990. With a few exceptions the nomenclature of the 180 or so species common to both is similar to the recent *Checklist of British marine Mollusca* by Smith & Heppell (1991) and should therefore be familiar to British readers. The remainder of the work comprises colour plates of every species.

In the introduction, the authors state that this work is the result of several years research conducted by the Picena Association of Malacology under the direction of Vincenzo Cossignani, supplemented by information from local collectors and experts. The result is a lavishly illustrated, pictorial identification guide to the shelled molluscs. On this basis we must assume that it is essentially aimed at the shell collector, particularly as the nudibranchs are completely omitted. Although the work covers all the species found in the central Adriatic, the majority occur elsewhere in the Mediterranean and also in the northeast Atlantic and will therefore be of use to workers in those areas.

A major difference between this and other regional shell guides is the inclusion of a colour photograph of every species. Although a few specimens are out of focus or over-exposed, overall the quality and reproduction of the photography is extremely good and would facilitate identification of the majority of the fauna. It is certainly ambitious to attempt to photograph in colour such groups as the pyramidellids and rissoids, for example, and it is for some of these small species that the book does not work so well. The problem does not lie so much in the difficulty of photographing such small species, but rather that live-collected material has not been selected for the purpose. There are several plates where beach worn shells, often with sand grains still in the aperture, have been used. This is a pity because important diagnostic features such as apertural teeth or shell sculpture are obscured or lost.

I am delighted that the authors have included all the molluscan classes, so often the chitons and bivalves are not accorded the same treatment as the gastropods. I am also pleased to see that they have included comprehensive, modern nomenclature in Latin and have not been tempted to use either Italian or English common names. As a biogeographer I would like to have had distributional and ecological information for each species, although a simple ACFOR abundance scale is used. I would like to think that a regional distribution atlas would be a natural successor and hopefully this work may stimulate such a venture. At Lire 65,000 (c. £30) it accords with other specialised books with relatively short print runs. Regional faunal projects need support and anyone interested in the Mediterranean marine malacofauna would find this work of interest and use.

Ian Killeen

Lakes and Snails: Environment and Gastropoda in 1,500 Norwegian Lakes, Ponds and Rivers by Jan Økland. U.B.S./Dr W. Backhuys, Oegstgeest, Netherlands. ISBN 90-73348-02-1, 1990. 516 pp, 316 figures and 102 tables. Price about £68.

How can one assess a man's lifework in just a few paragraphs? In this elegant monograph Jan Økland presents the results of research which began as an undergraduate project in 1953, with the objective of studying the distribution and ecology of freshwater snails in southeastern Norway. The fieldwork continued for a further 20 years and the scope of the project expanded to become the most comprehensive study of freshwater molluscs and their habitats ever undertaken.

The results are most impressive. They have been brought together in an A4 hardback book with text entirely in English. There are 13 main sections including methodology, the freshwater environment of Norway, environmental parameters, species distribution. There is a concise abstract and two excellent summary and discussion sections. I feel that a considerable amount of thought has gone into the style and layout of this work. With the vast amount of

data it presents it would be very easy to produce a complex, almost unreadable tome. However, there are a great number of sub-sections each with discussions and summaries. This makes for a very readable and accessible work, a feature that is particularly important for such a reference book.

There are 27 species of freshwater gastropod occurring in Norway of which only *Valvata sibirica* is not found in the British Isles. Thus much of these data and conclusions may be applied to species and environments in this country. A major chapter in the book is devoted to a species approach.

Each species is described and photographed, with comments on its distribution in Norway and surrounding areas and a discussion of its ecology in Norway. Of particular interest and use is the table summarizing the environmental factors that characterize the collection sites for each species. Also included are 4 distribution maps for each showing author's records, all records and 50 km square records for the whole country and a more detailed map for the southeastern study area. Although the focus for the study was southeastern Norway, the national coverage by the author is impressive by any standards and we can be sure that all the maps show real distribution patterns. A significant part of the fauna is restricted to the lowland areas in the southeast, although many extend well into the Arctic Circle. A species that might well catch the attention of the British reader is *Gyraulus acronicus*. In this country it is rare and possibly heading towards extinction, yet in Norway it is common, geographically widespread and is apparently catholic in its environmental requirements.

It is from the sections on environment and species that many of the most important conclusions are drawn. There are comprehensive analyses and descriptions of parameters such as geology, vegetation, surface water type and water chemistry. From a comparison of these data many relationships have been shown. For example it has been demonstrated that freshwater gastropods are sensitive to low pH, water hardness and the interaction between the two. The environmental implications are clear; freshwater snails are likely to be affected by acid rain and acidification of freshwaters and they are therefore important indicator species for environmental monitoring. On this basis this book will be an invaluable reference work.

This is so much of interest in this book and not just to malacologists and biogeographers. It will be of great value to limnologists, ecologists, conservationists, scientists in the water industry, students and so on. At £68 it is not unreasonably priced. A classic – thoroughly recommended.

Ian Killeen

PROCEEDINGS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

REPORT OF THE COUNCIL 1992–3

The Society announced with regret the deaths of three members: Dr. Vera Fretter, a member since 1976; Mr. P. Kingsbury, a member since 1980, and Mr. H. J. Garrett, a member since 1983.

The changes in Officers at the 1992 March A. G. M. were: Mrs. Susan Davies was appointed as Honorary Secretary and Mr. Paul Lee as Newsletter Editor.

The following were elected to serve as Council Members Janet Sawyer, Elizabeth Platts and Eleanor Forgan.

The Society's Membership numbers are as follows: 371 Ordinary and Family Members 174 Institution and Subscribers.

In 1992 the Society issued the following publications *The Journal of Conchology*, Volume 34, Part 3 in May, Part 4 in December.

This year the Society's Information leaflet has helped increase our new membership numbers. The new format Newsletter has also been warmly received by all members.

I would like to offer my personal thanks to Mr. Dave Guntrip for his assistance as Minutes Secretary and to Mrs. Beryl Rands for redirecting Conchological mail from all over the world.

Susan Davies
Honorary Secretary

PROGRAMME SECRETARY'S REPORT

The 1992 programme comprised 7 indoor meetings in London, a marine recording workshop in Dunoon, 9 field meetings and a molluscan workshop.

Lectures at indoor meetings were given by Mr. Tony Swann (Wheldon & Wesley), Dr. Andrew Johnson (Derby College), Mr. Fred Woodward, Dr. Robert Cameron (Birmingham University), Dr. Martin Bell (University of North Wales), and Dr. Andre Sandor. An open meeting was held in April as a late replacement for the arranged speaker. The Society is grateful to all of the above speakers.

In May, a weekend workshop, entitled 'Recording marine molluscs – the way forward' was held in Dunoon, Argyll. This was a particularly successful and well attended event. Thanks are due to the following contributors: Mrs. Jan Light, Dr. Allan Jones, Dr. Shelagh Smith, Mr. David McKay (DAFS), Dr. Julia Nunn, Mr. Roger Covey (JNCC), Ms. Cait Loretto (MCS) and to Mr. Peter Dow for his help in organising the meeting.

Field meetings were held at the following venues: Lathkill Dale, Derbyshire; Sandwich, Kent; Dunoon, Argyll; Peterborough; Weymouth; Pembrokeshire; Pewsey, Wiltshire; Scarborough; and Dorking, Surrey. We are grateful to all the leaders of these meetings: Dr. Peter Tattersfield, Mr. Brian Craig, Mr. John Bratton, Dr. Shelagh Smith, Mr. Mike Weideli, Mrs. Dorothy Cooper, Dr. Barry Colville and Miss Judith Nelson.

The Society held its eighth molluscan workshop in Godalming in November. Following the format of recent workshops, both marine and non-marine groups were covered. We extend our thanks to Mrs. Jan Light for again making her home available for this event.

TREASURER'S REPORT

The accounts for the year ended 31 December 1992 show an excess of income over expenditure of £2,589 (1991: £4,437) and a profit after transfer of reserves of £1,891 (1991: £2,416).

The fall in the amount of excess income has been caused by the increase in the cost of postage, the purchase of a microcomputer and a reduction in income from investments due to the fall in interest rates.

Fees and subscriptions were slightly lower at £12,068 (1991: £12,403) reflecting the fall in the number of members. Sales and donations showed a large increase (1,812 (1991: £749) due to significant efforts made by members in selling Society merchandise and back issues of publications.

Publication costs fell by £333 to £9,622 (1991: £9,955). A substantial reduction in the costs of the *Newsletter* has followed the change of printer. The increase in the costs of the *Journal* is largely the result of using better quality paper.

Stationary and postage costs increased due to the increase in postage rates and the printing of Society headed note-paper.

The Society has purchased a microcomputer for £624, which is included in sundry expenses. The costs of producing the Society merchandise is also included in sundry expenses.

Bank charges for the year amounted to £180 (1991: £140).

During the year the Borough of Bury redeemed its loan stock of £600. No investment was made to replace this, however it is intended to purchase approximately £5,000 of further investments in 1994.

Transfers were made to the Life Members Fund and Reserve and Research Fund from investment income. As the Life members fund is adequately funded, the transfer to this account was not required, so was transferred back to the Reserve and Research Fund and the income and expenditure account.

No further transfer was made to the publicity reserve, which now stands at £800 and is considered sufficient to fund the proposed purchases which will be made in 1993.

It was not considered necessary to increase the subscription rate for 1993. However, because of the projected increases in postage and general cost increases due to inflation, combined with falling income from interest yield investments, an increase in subscription rates of £2 for Ordinary members, Family members, UK Subscribers and overseas Subscribers is proposed for 1994. To reflect the increasing postage costs, the 1994 rates for overseas Subscribers and overseas Institutional members should rise by £5, to £40 and £35 respectively. This increase will not apply to overseas Subscribers if the publications are sent to a UK collecting agent, who will pay at the same rate as UK Subscribers.

A. D. Seccombe
Honorary Treasurer

RECORDER'S REPORT: NON-MARINE MOLLUSCA

All data are now with the Biological Records Centre at Monks Wood who will shortly be producing the maps for the new edition of the *Atlas*. This is to be published by Harley Books on behalf of the Society, under the title of *Atlas of the land and freshwater molluscs of Britain and Ireland*. The records from the 1992 season are the last that can be included. This does not however mean that further information will not be welcome, and the system of vice-comital authentication will continue as before and increments be published annually. The focus nevertheless will in future move increasingly towards local, tetrad-based schemes, usually covering counties or smaller areas.

The following have been authenticated since the last Report (*J. Conch., Lond.* **34**, p. 253). The collection date was in all cases 1992 unless stated otherwise. The Irish records of *Anodonta* date from the period 1987–92.

Somerset South (5): *Pisidium moitessierianum*, Creech St. Michael (31/2725), A. G. Smith.

Kent East (15): *Pisidium pseudosphaerium*, Sandwich (61/3259; dead shell), G. E. H. Long, 1989.

Oxford (23): *Macrogastra rolphii*, Wilcote (42/3615), A. I. Spriggs.

Cambridge (29): *Pisidium pseudosphaerium*, Wicken Fen (52/5670), D. Painter.

Gloucester East (33): *Menetus dilatatus*, Gloucester-Sharpness Canal, Quedgeley (32/8014), D. C. Long.

Gloucester West (34): *Pisidium moitessierianum*, Gloucester-Sharpness Canal, Frampton on Severn (32/7406), D. C. Long.

Glamorgan (41): *Ferrissia wautieri*, Ryer's Moor, Gower (21/4592), Mericia Whitfield, 1990.

Carmarthen (44): *Planorbarius corneus*, Trenel, Pembrey (22/4201). I. K. Morgan and R. D. Pryce.

Lancs South (59): *Pisidium moitessierianum*, Bridgewater Canal. Astley Green (33/7099), G. Musker.

York Mid-west (64): *Limax maculatus*, Arncliffe (34/9371), A. Norris.

Cumberland (70): *Monacha cantiana*, Nether Wasdale (35/10), K. N. A. Alexander, 1980.

Kirkcudbright (73): *Vertigo angustior*, White Port (25/8451), B. Colville.

Lanark (77): *Leiostryla anglica*, New Lanark (26/8842), T. Huxley.

Perth Mid (88): *Anisus vortex*, *Pisidium henslowanum*, Fordun Loch (27/9515), T. Huxley.

Forfar (90): *Milax gagates*, Dundee (37/4231); *Milax budapestensis*, *Limax flavus*, Montrose (37/7158); *Milax sowerbyi*, Arbroath (37/6340), all A. T. Sumner.

Clyde Isles (100): *Arion flagellus*, *Arion fasciatus*, *Deroceras caruanae*, Lagg, Isle of Arran (16/9521); *Arion owenii*, Mid-Thundergay, Arran (16/8846), all A. T. Sumner.

Kintyre (101): *Milax sowerbyi*, *Deroceras caruanae*, Campbeltown (16/7220), A. T. Sumner.

Mid Ebudes (103): *Bathyomphalus contortus*, Tiree (07/9642), T. Huxley.

Ross West (105): *Ceruella virgata*, Mellon Udrigle (18/8995), R. H. Lowe.

Kerry North (H2): *Anodonta anatina*, R. Galey (01/9536), J. Lucey.

Cork East (H5): *Anodonta cygnea*, R. Bride (10/8992), J. Lucey.

Waterford (H6): *Anodonta cygnea*, R. Blackwater (20/0698), J. Lucey.

Limerick (H8): *Anodonta anatina*, R. Deel (11/3539), J. Lucey.

PROCEEDINGS

Tipperary North (H10): *Anodonta anatina*, Little Brosna River (22/0402), J. Lucey.

Kilkenny (H11): *Anodonta cygnea*, *Anodonta anatina*, R. Barrow (21/7143), J. Lucey.

Carlow (H13): *Anodonta cygnea*, *Anodonta anatina*, R. Barrow (21/7143), J. Lucey.

The outstanding find among terrestrial species is of *Vertigo angustior* at White Port, Kirkcudbrightshire, the first time this rare snail has been found living in Scotland. The habitat is mossy grassland on blown shell-sand just above high-water mark. Dead shells had been found at or near the same spot in 1974 but their age was uncertain. Along the west coast of Scotland there are reports of dead shells or of fossils from similar contexts on Colonsay and from the Hebrides.

As in 1991, Dr. Sumner has extended our knowledge of slugs in Scotland. His most noteworthy find is perhaps of *Arion owenii* on Arran.

The other interesting discoveries of the year are all of aquatic species. First, two introduced gastropods. The North American planorbid *Menetus dilatatus* has been found in the Gloucester-Sharpness Canal, representing a considerable extension of range. It may be noted that it occurs in the canal with *Sphaerium transversum* and with *Physa* of 'heterostropha' type, both also of North American origin. The exotic limpet *Ferrissia wautieri*, first found in this country in an open habitat in 1976, has now appeared in Wales.

Among the bivalves, several *Pisidium* species are worthy of note. The rare *Pisidium pseudosphaerium* has been found in marshland levels in Kent and in Cambridgeshire. *Pisidium moitessierianum* can be added for three further vice-counties, in all cases living in canals. *Pisidium henslowanum* has been found in a shallow eutrophic loch in Mid Perthshire. It is a rare species in Scotland and the present site in Fordun Loch is the most northerly known. It was associated with *Anisus vortex*, also very local in Scotland and similarly new to v.c. 88.

Finally, our knowledge of the distribution of the two species of *Anodonta* in southern Ireland has been greatly enlarged by the extensive fieldwork of John Lucey. *Anodonta cygnea* is new in four vice-counties and *A. anatina* in five.

M. P. Kerney

RECORDER'S REPORT: MARINE MOLLUSCA

A regional meeting devoted to the subject of Marine Recording was held in Dunoon, West Scotland in May 1992. A number of Sea Area representatives attended this meeting as well as staff from Marine Conservation Society, Marine Nature Conservation Review of JNCC and DAFS. This was a successful and worthwhile meeting at which plans for mapping to a fine unit within Sea Areas were elaborated upon, in addition to proposals for future regional atlases, such as a Channel Atlas, which will involve cooperation between Sea Area representatives at a local level.

In April some members of the Society joined Dr J. Nunn for an intensive shore recording effort in South West Ireland. This initiative received a grant from the Praeger Fund in Ireland and during the course of 8 days, some 65 sites were surveyed and a considerable amount of new information was accumulated for an Irish Atlas of Marine Molluscs. One of the features of the Society's field meeting programme is to focus on areas which have received little attention in recent years. A field meeting to Scarborough was supported by 14 members. During the 5 days we looked at several sites between Whitby and Filey and gained comprehensive lists for that stretch of coast.

During the year, two newcomers have become involved in the Marine Census, Tom Clifton who is now area representative for S23 (Anglesey) and S24 (Liverpool Bay) and Beverley Wilson based at Port Erin who takes over S26 (Isle of Man).

I am delighted to welcome new blood to the scheme but there are still some sea areas which I regard as vacant. Can I therefore urge any interested parties to get in touch with me if they would like to consider becoming involved in marine recording.

Active and prolific contributors of recent years have continued to submit data and new records. In particular, recording on the south east coast and East Anglia had yielded a number of species which are completely new to S13 and S14 and several more records for *Noemiamea dolioliformis*.

Recently specimens of *Cuthona viridis* (det. B.E. Picton) were obtained from Dovercourt, Harwich and Felixstowe. An abundance of records from an area which might be placed at a low level on a scale of marine biological interest highlights the value of fine unit mapping where visits are made to shores outside traditional mollusca-rich areas.

In thanking regular contributors to the Scheme, I would also like to especially acknowledge the input during the year of Judith Nelson and Sebastian Payne. Thanks are also due to Tom Clifton and Ian Killeen who have prepared gridded maps for individual sea areas – 10 of these have now been produced for local mapping. I am again grateful to MAFF for making data from their South Coast Surveys available to me.

Finally, I was sorry to receive a letter from my predecessor early this year in which he expressed the wish to hand on responsibility as area representative for S16, whilst nevertheless maintaining close involvement through his work with the Fleet Study Group. I am sorry to lose a colleague who was instrumental in my involvement in marine recording and extend my personal thanks to Dennis as well as the thanks of the Society for his contribution to the Scheme.

**CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND
ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1992**

INCOME AND EXPENDITURE ACCOUNT

	31.12.92	31.12.91
	£	£
<i>Income</i>		
Fees and subscriptions	12,068	12,403
Investment Income	3,364	4,033
Sales/Donations	1,413	582
	16,845	17,018
<i>Expenditure</i>		
Publication costs	9,622	9,955
Stationery and postage	2,297	1,457
Meetings	525	420
Sundry	1,812	749
	(14,256)	(12,581)
Excess of income over expenditure	2,589	4,437
Transfer to publicity reserve	—	(400)
Transfer (to)/from Reserves:		
Reserve and Research fund	(577)	(807)
Life Members' Fund	(585)	(814)
Life Members' Fund	464	—
Profit for the year	1,891	2,416

PROCEEDINGS

CONCHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND
ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1992

BALANCE SHEET

Note	31.12.92	31.12.91
	£	£
<i>Assets</i>		
Investments	16,963	17,663
Cash	16,070	15,154
Debtors	1,325	1,287
	34,358	34,104
<i>Liabilities</i>		
Creditors and accrued charges	2,863	4,164
Advance subscriptions	1,567	2,601
Life members fund	4,614	4,614
Reserve and research fund	5,252	4,554
Publicity reserve	800	800
	15,096	16,733
	19,262	17,371
Represented by:		
Capital account brought forward	17,371	14,955
Profit for the year	1,891	2,416
	19,262	17,371

A. D. SECCOMBE (*Honorary Treasurer*)

A. N. LIGHT FCA

D. WORTH (*Honorary Auditors*)

INSTRUCTIONS TO AUTHORS

Manuscripts should be sent to:— **The Hon. Editor, Dr R. C. Preece, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ.**

PAPERS Two copies of text and illustrations should be submitted; one set of illustrations must be good quality originals. Authors should refer to recent copies of the *Journal* for a guide to format. Authors are reminded of the high cost of printing and therefore are expected to write concisely and to make maximum use of page size when designing art-work and tables.

COMMUNICATIONS These are intended to be short notes of an original nature which do not merit the treatment of a full paper. *Communications* must not contain any figures, tables or plates and should conform in style to that of recent issues of the *Journal*.

Journal of Conchology

Vol. 34, Part 6, January 1994

Contents

PAGE

PAPERS

- R. N. KILBURN —On the identity of *Pleurotoma* (*Defrancia*?) *piperata* E. A. Smith, 1882, A West American Columbellid described from Korea (Gastropoda: Columbellidae) 347
- J. R. ARRÉBOLA BURGOS AND E. GITTENBERGER—New distributional data for *Rupestrella dupotetii* (Terver) (Gastropoda: Chondrinidae) from Southern Spain and NW. Africa, with notes on allegedly subspecific characters . . . 351
- D. T. HOLYOAK AND M. B. SEDDON—Further notes on the Aciculidae (Gastropoda: Prosobranchia) of NW. Africa 357
- A. OUTEIRO, D. AGÜERA AND C. PAREJO—Use of Ecological Profiles and Canonical Correspondence Analysis in a study of the Relationship of Terrestrial Gastropods and Environmental Factors 365
- T. RODRIGUEZ AND J. HERMIDA—Key to the identification of the slugs (Gastropoda: Pulmonata) of Portugal 377

COMMUNICATIONS

- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE 393
- J. LUCEY AND F. B. DEVERY—*Anodonta cygnea* (L.) in soft water 394
- H. MEREDITH—*Theba pisana* (Müller) now widespread along part of the north Cornish coast 394
- C. STÉVANOVITCH—*Oxyloma sarsi* (Esmark, 1886) in France 395
- REVIEWS 397
- PROCEEDINGS 399

067 PB XL 261
09/07/95 198115
INFORMATION CONSERVATION INC
SOLE

JOURNAL OF CONCHOLOGY, VOLUME 34

TAXONOMIC NOMENCLATURE INDEX

Note: Species names are indexed in alphabetical order according to genus; species newly described in volume 34 of the Journal are listed in bold type.

Abida vasconica 164
Acanthinula aculeata 113, 177, 325
Achatina erecta 339
A.oryza 116
Acicula algerensis 357
A.benoiti 357
A.fusca 186, 253
A.lallamanti 357
A.norrisi 358
Aciculidae 357
Aclididae 117, 257
Aclis gulsonae 257
Acroloxus lacustria 113, 253
Acteon pelecais 145
A.punctostriatus 146
A. tornatilis 143
A.traski 145
Acteonidae 143
Aegopinella nitidula 68, 177
A.pura 177
Afroconulus iredalei 39
Aglajidae 199
Agriolimacidae 379
Akera soluta 202
Allopeas 339
Alvania crassa 117
A. semistriata 117
Ampullariidae 31, 345
Ancylus fluviatilis 175, 394
Anisus leucostoma 256
A.vortex 400
Anodonta anatina 113, 183, 306, 400
A.cygnea 306, 394, 400
Anodontidae 183, 394
Anostoma beileyi 183
A.depressum 184
A.globulosum 184
A.luetzelburgi 184
A.lüzelburgi 184
A.octodentatum 184
Anostoma octodentatum brunneum Verdcourt, 1991
81
A.ringens 184
A.rossi 184
A.spp. 183
A.verreauxianum 184
A.verreuxi 184
Aplexa hypnorum 113
Aplysia depilans 115
A.fasciata 115
A.limacina 115
A.melanopus 115
Aplysiidae 115
Architeuthis clarkei 126
A.dux 126
A.harveyi 126
A.monachus 126
A.princeps 126
Arculus sykesi 117
Arion ater 117, 380
A.circumscriptus 177
A.fasciatus 253, 400
A.flagellus 113, 253, 400
A.fulgineus 380
A.hispanicus 380
A.hortensis 256
A.hortensis agg. 177
A.intermedius 164, 177, 380
A.lusitanicus 113, 380
A.moreleti 26
A.nobrei 380
A.owenii 253, 400
A.silvaticus 177
A.subfuscus 177
Arionidae 19, 256, 380
Ashfordia 165
Ashfordia granulata 186, 256
Assiminea grayana 254,256
Assiminidae 256
Atys cylindricus 202

Balcis montagui 256
Balea 255, 393
Balea perversa 117
Bassina caluphylla 258
Bathyomphalus contortus 400
Bathyteuthis 3
Belemnites 393
Belemnites paxillosa 393
Belemnitidae 393
Bithyniidae 31
Boettgerilla pallens 113, 253
Brachystoma scalaris 258
Bucardium coronatum 258
Buccinum acicula 393
Bulimulidae 81, 183

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

- Bulimus gracilis* 339
B.maderensis 116
B.reboudi 153
Bulinus globosus 35
B.jousseamei 35
B.senegalensis 31
Bulla ampulla 199
Bursa bardeyi 225
- Caelatura aegyptiaca* 31
C.juliani 35
C.mweruensis 35
C.schoutedeni 35
Candidula 167
Cardiidae 139
Cardium exiguum 139
Carychium minimum 177, 186, 222, 322
C.tridentatum 177
Catinella arenaria 215, 321
Catriona gymnota 252
Cecilioides acicula 68, 113, 164, 253, 393
Cecilioides spp. 155
Cepaea hortensis 177
C.nemoralis 68, 177
Cephalopoda 339, 343
Cerastoderma glaucum 139
Cernuella cespitum 367
C.vestita 367
C.virgata 67, 367, 400
Chelidonura hirundinina 202
C.sandrana 199
Chelynotus semperi 73
Chlamys opercularis 44
C.septemradiata 45
C.tigerina 44
Chondrina farinesii granatensis 353
C.gasulli 259
C.kobelti 164
Chondrinidae 259, 351
Chrysallida indistincta 257
Clausilia bidentata 177
Clausiliidae 255
Clavatula coerulea 86
Clavidae 183
Clavinae 183
Clavusinae 183
Cochlicella acuta 253
C.barbara 367
Cochlicopa lubrica 177, 186, 215
C.lubricella 68, 177, 215
C.nitens 215
C.repentina 224
Cochlicopidae 215
Cochlodina laminata 113, 253
Cochlostyla spp. 123
Codakia decussata 115
Columbellidae 347
Columella 37
Columella aspera 177
C.columella 222
Comarmondia gracilis 342
Conidae 7, 183, 393
- Conus achatinus* 12
C.ammiralis 11
C.arenatus 13
C.aulicus 13
C.aurantius 13
C.auriocomus 13
C.aurisiacus 12
C.berghausi 183, 393
C.betulinus 13
C.bullatus 13
C.capitaneus 12
C.catus 12
C.cedonulli 12
C.clavus 14
C.demissus 183, 393
C.ebraeus 13
C.figulinus 13
C.fulmen 183, 393
C.generalis 12
C.genuanus 12
C.geographus 13
C.glaucus 9
C.gloriamaris 5
C.granulatus 13
C.imperialis 12
C.litoglyphus 12
C.litteratus 12
C.magus 12
C.marmoreus 12
C.mercator 13
C.miles 12
C.minimus 12
C.modestus 183
C.monachus 12
C.nobilis 12
C.nussatella 13
C.omaria 13
C.princeps 7
C.pulcher 13
C.rusticus 12
C.spectrum 13
C.spurius 12
C.stercusmuscarum 13
C.striatus 13
C.terebellum 13
C.terebra 13
C.textile 5, 13
C.tulipa 13
C.varius 13
C.virgo 12
C.zebra 12
Corbicula striatella 258
Corbula gibba 257
Coriocella hibyae Wellens, 1991 73
C.nigra 77
Crenilabrum exilis 145
Ctena decussata 115
Cuthona viridis 401
Cycloceras laevigatum 393
Cyclostoma calcareum 334
C.insulare 334
C.letourneuxi 333

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

- C.sulcata* 334
 Cymatiinae 183
Cymatium ranzanii 225
Cystiscus bubistae 88
C.gutta 87
Cystiscus josephinae Fernandes & Rolán, 1991 85
- Defrancia* 347
Dentaspatharia 103
Dentaspatharinae 103
Deroceras agreste 254
D.caruanae 254, 400
D.geresiensis 379
D.hispaniensis 379
D.laeve 177, 186, 379
D.lombricoides 379
D.nitidum 379
D.panormitanum 379
D.reticulatum 164, 177, 256, 279
Diplodonta sp. 258
Discus abietinus 327
D.rotundatus 67, 177, 256, 327
D.ruderatus 222
- Egouena* 188, 237
Elliptio complanata 274
Ena obscura 68, 326
 Endodontidae 259
Ensis americanus 109
Eremina dillwyniana 155
Etheria elliptica 31
 Etheriidae 31
Euconulus alderi 186
E. cf. alderi 328
E.fulvus 116, 177, 256
E.fulvus agg. 221
Eulima 255
 Eulimidae 393
- Ferrissia wautieri* 113, 253, 400
 Ferussaciidae 393
Furcopenis circularis 379
- Galiteuthis armata* 126
Gasullia 212
Geomalacus anguiformis 19, 380
G.maculosus 380
Geomalacus malagensis Wiktor & Norris, 1991 19
G.oliveriae 380
Gibberula cucullata 89
G.modica 89
G.punctillum 88
Gittenbergia sororcula 321
Granopupa dupotetii 352
G.granum 155, 329
Granulina parilis 87
Graphis alibida 117
Guppya rumrutiensis 39, 185
Gyraulus acronicus 38
G.laevis 113
- Haedropleura septangularis* 257, 341
Haliotis mariae 225
Haminaea alfredensis 202
H.natalensis 202
H.zelandiae 202
Haustator 256
Hawaiiia minuscula 328
Helicarion 256
Helicarion cuvieri 256
Helicella argonautula 56
H. cf. saadensis 329
H.conspurcata 367
H.itala 64, 164
H.sp. 155
 Helicellinae 47
 Helicidae 47, 159, 205, 394
Helicodiscus inermis 330
H.scintilla 329
H.singleyanus 113, 253, 321
Helicopsis conopsis 47
H.turcica 47
Helix argonautula 56
H.armillata 116
H.aspersa 68, 256, 329, 367
H.barbata 339
H.barclayi 172
H.calabarica 184
H.candiata 255
H.candiota 393
H.caniculensis 116
H.cyclostremoides 48
H.lincta 116
H.mogadorensis 48
H.mograbina 48
H.papilio 116
H.ringens 184
H.subturritula 169
H.talcosa 184
H.turbinata 255
H.turcica 48
H.vulgata 116
Hesseola 165
Hyala vitrea 257
Hyalina pellucida 188
Hydrobia neglecta 59
H.ulvae 59, 175
H.ventrosa 59
 Hydrobiidae 59, 255
Hygromia cinctella 253
H.limbata 253
 Hygromiidae 159, 255
- Idiosepioidea 343
Inopinodon azoricus 145
 Iravadiidae 257
 Iridinae 103
- Janthina* 5
Janthina janthina 124
Japonacteon pusillus 145

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

- Kaliella barrakporensis* 185
K.fourneauxensis 172
K.iredalei 185
K.subcrenulata 170
K.subturritula 169
Kobeltia 256

Lacuna pallidula 258
Laeocochlis 393
Lambis violacea 123
Lamellaria diegoensis 76
L.inflata 77
L.mauritiana 77
L.perspicua 76
L.tongana 77
L.utinonii 76
lamellarid opisthobranch 73
Lamprocystis misella 173
Lauria cylindracea 65, 164, 177, 325
Ledoulxia gwendolinae 179
L.pseudojenynsi 179
Lehmannia 37
Lehmannia marginata 380
L.valentiana 380
Leiostyla anglica 177, 186, 259, 311, 400
L.gottschicki 317
L.numidica 311
Leptochiton scabridus 117
Leptochitonidae 117
Letourneuxia numidica 19
Leucochroa degenerans 48
Liardetia doliolum 170
L.sculpta 169
L.samoensis 170
Lienardia piperata 348
Limaecidae 68, 380
Limax flavus 254, 380, 400
L.maculatus 253, 400
L.marginatus 177
L.maximus 380
L.tenellus 113, 253
Lindholmiola barbata 339
Loligo forbesii 126
L.vulgaris 126
Lousia barclayi 169
L.duponti 172
L.insularis 169
Lucina anomala 103
Lucinella divaricata 116
Lucinidae 115
Lymnaea glabra 113, 253
L.palustris 256
L.peregra 177
L.stagnalis 113, 253
L.truncatula 177, 186, 221, 256, 322
Lymnaeidae 39

Macrogastra rolphii 400
Mactra complonata 258
Maizania marsabitensis 39
Maizaniidae 39

Mangelia attenuata 341
M.costulata 342
M.melanosticta 347
M.nebula 341
M.powisiana 341
M.smithii 342
Marcia hiantina 258
M.recens 258
Margaritifera auricularia 268
M.brunneus 268
M.durrovensis 267
M.falcata 274
M.margaritifera 267, 301, 394
Margaritiferidae 267, 301
Marginella ameliensis 189
M.amygdales 188
M.angolensis 193
M.avena 187
M.benguelensis 192
M.bivittata 189
M.cantharus 191
M.chalmersi 89
M.evanida 192
M.eveleighi 86
M.fusiformis 195
M.gemma 85
M.liparozona 85
M.melvilli 85
M.nitida 187
M.perexilis 240
M.spinacia 86
M.walwisiana 191
Marginellidae 85, 187, 237
Massylaea spp. 155
Mastus pupa 259
Maxacteon cratericulatus 145
Melanella alba 255
M.polita 393
Melanchlamys 202
Melanchlamys cylindrica 202
Menestho diaphana 257
M.dolioliformis 117, 258
Menetus dilatatus 400
Mengoana brigantina 164
Meretrix casta 258
Mesafra mesafricana 35
Mesodontidae 339
Metathea 165
Milacidae 380
Milax budapestensis 400
M.gagates 380, 400
M.sowerbyi 400
Moaria chaperiana 184
M.conica 184
Monacha cantiana 400
M.cartusiana 167
Monodonta lineata 339
Montserratina 167
Mutela ovata 31
Mutelidae 31, 103
Mysella bidentata 257
Mytilidae 183

- Mytilus anatinus* 183
Myxas glutinosa 39, 113

Nassarina melanosticta 347
N.monilifera 349
N.piperata 347
Nautilus pompilius 123
Navanax inermis 202
Nerita fluviatilis 91
Neritidae 91
Neritina fluviatilis 91
Nesovitrea hammonis 68, 177
N.petronella 222
Noemiamea dolioliformis 117, 258, 401
Nucula nucleus 257
N.sulcata 257
Nuculoma tenuis 257

Obscurella bicostulatum 164
O.hidalgoi 164
Octopodoteuthis persica 339
Odostomia plicata 117
O.turrita 258
Oestophora gasulli 205
Oestophorella buvinieri 164
Ommastrephes bartramii 125
O.caroli 125
Ommastrephidae 125
Ondina diaphana 257
O.perezi 257
Onoba semicostata 117
O.vitrea 257
Ovatella myosotis 253, 256
Oxychilus alliarius 65, 177
O.cellarius 177
O.draparnaudi 68, 367
O.hydatinus 259, 328
Oxyloma elegans 395
O.pfeifferi 186, 221, 256, 321
O.sarsi 395

Paehoplita 165
Paludinella litorina 252
Parennea 71
Parmacella valencienni 380
Parmacellidae 380
Partulida spiralis 258
Parvicardium hauniense 139
P.ovale 257
Patula marthae 321
Pecten maximus 41
P.meridionalis 44
Pectinidae 41
Peleyora cylanica 258
P.excisa 258
Perforatella 37
Persicula thomensis 85
Philbertia gracilis 342
P.linearis 342
Philine auriformis 202
Philinopsis capensis 202

P.cyanea 199
P.taronga 202
Philonesia 172
Physa acuta 253
Pillucina fischeriana 258
Pisidium amnicum 253
P.casertanum 177, 221
P.henslowanum 400
P.moitessierianum 113, 400
P.personatum 177
P.pseudosphaerium 113, 400
P.supinum 113, 253
P.tenuilineatum 253
Placopecten magellanicus 45
Plagyrona debeauxiana 326
P.placida 326
Planogyra sororcula 329
Planorbarius corneus 253, 400
Planorbiidae 31
Planorbis carinatus 253
Platyla polita 357
Playgyrona debeauxiana 259
P.placida 259
Plentuisa Puente & Prieto, 1992 159
Plentuisa vendia Puente & Prieto, 1992 159
Pleurobranchidae 393
Pleurobranchus forskahli 393
P.forskalii 393
P.testudinarius 393
Pleurotoma piperata 347
Polygyra 339
Polygyra semptemvolva 339
Polygyridae 339
Pomatias elegans 164
Pomatiasidae 185, 333
Ponentina subvirescens 166
Potamlithus 255
Potamolithus rushii 255
Potamopyrgus jenkinsi 254, 256, 394
Prisodontopsinae 103
Prisodontopsis 103
Prisodontopsis johnstoni 104
Prisodontopsis aviculaeformis nom. nov. 103
Prohyria 104
Prunum 188, 237
Prunum amphorale de Souza Jr., 1992 237
Pseudamnicola confusa 254, 256
Pseudavicula 103
Pseudaviculinae 103
Pseudocaldwellia 173
Pseudoctobranchia 343
Ptychotrema aequatoriale 71
Punctum poupillieri 326
P.pusillum 259
P.pygmaeum 68, 177, 186, 211, 256
Pupa coenopicta 151
P.kirki 145
P.solidula 145
Pupilla L'Eprevieri' 321
P.muscorum 64, 164, 221, 321
P.triplicata 321
Pupillidae 149, 259, 311

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

Pupoides aethiopicus 151
P.astieranis 151
P.cerealis 149
P.coenopictus 149
P.doriae 151
P.euphraticus 151
P.fabianus 151
P.fallax 151
P.gemmula 150
P.harti 151
P.hoggarensis 151
P.kursiensis 151
P.lardeus 151
P.maharasicus 151
P.marebiensis 151
P.marginatus 153
P.putilla 149
P.putillus 151
P.ragius 151
P.reboudi 151
P.senaariensis 149
P.senegalensis 149
P.sennaaricus 151
P.soror 151
P.tutulus 151
P.vermiformis 149
Pyramidellidae 117, 257, 258
Pyramidula rupestris 164

Ranellidae 183
Raphitoma linearis 342
Renea letourneuxi 357
Ringicula sp. 199
Rissoa interrupta 258
R.parva 258
Rumina decollata 155, 367
Rupestrella dupotetii 351
R.dupotetii dupotetii 354
R.dupotetii sebouensis 352

Saulea vitrea 31
Schileykiella 167
Segmentina nitida 113
Semisalsa stagnorum 59
Sepiella japonica 343
Sierraia leonensis 31
S.whitei 31
Sinistralia gallagheri 225
Sitala jenynsi 179
Spermodea lamellata 177
Sphincterochila cf. *candidissima* 155, 329
Spiraxis mandarinus 339
Steironepion 347
Sthenoteuthis pteropus 125
Streptaxidae 71
Strombiformis 255
Strombiformis albus 255
Suboestophora gasulli nov. comb. 205
Succinea putris 256
Succineidae 395
Szentgalia 165

Taningia danae 339
T.persica 339
Taonidium pfefferi 126
Tellina capsoides 258
T.iridescens 258
Testacella maugei 380
Testacellidae 380
Theba pisana 367, 394
Theodoxus fluviatilis 91
Thyrreniella 167
Thysanoteuthis rhombus 126
Timoclea crakana 258
T.imbricata 258
T.ovata 257
Toltecia pusilla 259, 367
T.pusillum 321
Tomlinula turritus 145
Tortaxis 339
Trichia 37
Trichia hispida 68, 160, 256
T.plebeia 253
Tridacna gigas 123
Tridonta montagui 257
Trochidae 231, 339
Trochita dhofarensis 225
Trochochlamys crenulata 170
T.subcrenulata 170
Trochonanina gwendolinae 179
T.mozambicensis 182
Trochus turcicus 48
Tropidophora articulata 185
T.barclayana 285
T.calcareo 333
T.hanningtoni 333
T.michaudi 185
Truncatella subcylindrica 252
Truncatellina callicratis 367
T.sp. 186
Turbinella pyrum 123
Turbinidae 225
Turbo bruneus 225
T.canaliculatus 225
T.fluctuosus 225
Turbo jonathani Dekker, Moolenbeek & Dance, 1992 225
T.laevis 256
T.marmoratus 225
T.politus 393
Turridae 257, 341
Umbonium eloiseae Moolenbeek & Dekker, 1992 231
U.vestiarium 231
Unio galloprovincialis 104
U.johnstoni 103
U.juliani 34
Unionidae 31, 103
Urocyclidae 179
Vallonia costata 65, 164, 221, 253, 321, 367
V.costellata 116
V.enniensis 116, 221
V.excentrica 67, 164, 253

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

- V. pulchella* 113, 116, 221, 329, 367
Valloniidae 116
Valvata cristata 253
V. sibirica 398
Vampyroteuthis infernalis 343
Veronicellidae 37
Vertiginidae 185, 186, 259
Vertigo angustior 221, 400
V. antivertigo 113, 186, 221, 222, 253, 321
V. briobia 321
V. capellini 321
V. codia 321
V. discheilia 321
V. dupotetii 351
V. genesii 215
V. geyeri 222
V. graellsiana 324
V. lilljeborgi 185, 186, 253
V. maresi 321
V. microlena 321
V. moulinsiana 113, 186, 221, 321
V. priscilla 317
V. pusilla 176
V. pygmaea 68, 177, 186, 221, 321
V. substriata 113, 177, 186, 222, 259
Villorita sp. 258
Vitrea contracta 68, 164, 177, 367
V. crystallina 113, 177
Vitrina behnii 116
V. pellucida 117, 221
Vitrinidae 37
Volutidae 344
Volvaria triticea 187
Volvarina 237
Volvarina abbotti 241
V. ameliensis 187
V. angolensis 193
V. capensis 188
V. cf. deliciosa 188
Volvarina fugax Gofas & Fernandes, 1992 187
V. insulana 85, 188
V. mitrella 187
V. pauli 240
Volvarina peregrina Gofas & Fernandes, 1992 187
Volvarina riparia Gofas & Fernandes, 1992 187
V. sauliae 192
V. unilineata 195

Xeroleuca 47
Xeroleuca antoinei 56
X. babelis 48
X. brulardi 48
X. chabertiana 48
X. degenerans 49
X. depressiuscula 48
X. gouluminensis 56
X. mazancourtiana 56
X. mogadorensis 49
X. mognabina 49
X. rebiana 48
Xeromicra 166
Xeromunda 255, 393
Xerophila babelis 49
Xerotricha 166
Xerotricha apicina 166

Zenobiella subrufescens 177
Zonitidae 259
Zonitinae 37
Zonitoides arboreus 321
Z. excavatus 177, 253
Z. nitidus 175, 186, 321
Zootechus insularis 155

GENERAL AND GEOGRAPHICAL INDEX

- Adriatic Sea, marine molluscs 397
Africa, *Prisodontopsis aviculaeformis* 103
Africa, *Ptychotrema aequatoriale* 71
Africa, E, *Tropidophora hanningtoni* 333
Africa, NW, Aciculidae 357
Africa, NW, *Helicopsis* spp. 47
Africa, NW, land snail records 321
Africa, NW, *Leiostyla* spp. 311
Africa, NW, *Pupoides coenopictus* 149
Africa, NW, *Rupestrella dupotetii* 351
Africa, W, *Volvarina* spp. 187
Algeria, Aciculidae 357
Algeria, land snail records 321
Algeria, *Leiostyla* spp. 311
Algeria, *Pupoides coenopictus* 149
Algeria, *Rupestrella dupotetii* 351
America, W, *Pleurotoma piperata* 347
anatomy of *Geomalacus malagensis* 26
anatomy of *Margaritifera durrovensis* 267
Anglesey, *Vertigo lilljeborgi* 185
Angola, *Volvarina* spp. 187
Arabian Sea, estuarine bivalves 258
Arabian Sea, *Umbonium eloiseae* 231
Atlantic, *Prunum amphorale* 237
Atlantic, E, marginellids 85
Atlantic, E, *Volvarina* spp. 187
Atlantic, NE, 2 rare sea snails 117
Atlantic, NE, *Aclis gulsonae* 257
Atlantic, NE, *Aplysia depilans*, *A. fasciata* 115
Atlantic, NE, *Codakia decussata* 115
Atlantic, NE, Cephalopoda 343
Atlantic, NE, *Hydrobia* spp. 60

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

- Atlantic, NE, *Leptochiton scabridus* 117
 Atlantic, NE, marine mollusc distrib. 83
 Atlantic, NE, marine molluscs 108, 249, 401
 Atlantic, NE, *Monodonta lineata* 339
 Atlantic, NE, *Noemiamea dolioliformis* 258
 Atlantic, NE, *Pecten maximus* 41
 Atlantic, NE, *Sthenoteuthis pteropus* 125
 Atlantic, NE, turrid records 341
 Australia, non-marine Mollusca 265
- Baltic Sea, *Parvicardium hauniense* 139
 biology of slugs (book) 264
 bodies of Portuguese slugs 380
 body colours, *Volvarina* spp. 196
 body of *Chelidonura sandrana* 201
 body of *Chelyonotus semperi* plate (80–1)
 body of ***Coriocella hibyae*** plate (80–1)
 body of ***Geomalacus malagensis*** 20
 body of *Philinopsis cyanea* 200
 body of ***Umbonium eloiseae*** 232
 book and publication reviews 83, 148, 261, 262, 263, 264, 265, 343, 344, 345, 397
 Bourguignat, J.R, *Moaria chaperiana?* 184
 Brazil, ***Anostoma octodentatum brunneum*** 81
 Brazil, *Anostoma* spp. 183
 Brazil, ***Prunum amphorale*** 237
 Bristol Channel, island, land snails 63
 British Isles, 2 rare sea snails 117
 British Isles, *Aplysia depilans*, *A. fasciata* 115
 British Isles, *Codakia decussata* 115
 British Isles, *Leiostyla* spp. 311
 British Isles, marine mollusc distrib. 83
 British Isles, marine molluscs 109, 249, 401
 British Isles, marine spp. checklist 261
 British Isles, non-marine molluscs 112, 249, 400
 British Isles, *Sthenoteuthis pteropus* 125
- Cephalopoda of Iberia 343
 Checklist, British marine molluscs 261
 chiton, *Leptochiton scabridus* 117
 Cnidaria, Clavinae gastropod homonymy 183
 coloration of *Cystiscus josephinae* plate (90–1)
 colour morphs of scallop 41
 Compendium of Seashells (book) 148
 conservation, *Margaritifera* in Ireland 267
 conservation, UK Red Data Book 262
 control of slugs (book) 264
 Cornwall, *Aplysia depilans*, *A. fasciata* 115
 Cornwall, *Codakia decussata* 115
 Cornwall, *Theba pisana* 394
 CSGBI, Council Reports 107, 249, 399
 CSGBI, Financial Accounts 110, 402
 CSGBI, Marine Recorder's Reports 109, 252, 401
 CSGBI, Non-marine Recorder's Reports 112, 253, 400
 CSGBI, Programme Secretary's Reports 108, 249, 399
 CSGBI, Treasurer's Reports 109, 250, 399
- dog-whelk, sinistral 4
 Dorset, *Monodonta lineata* 339
- ecology of Aciculidae of NW Africa 357
 ecology of Eocene marine molluscs 265
 ecology of *Hydrobia* 59
 ecology of land snails of Flat Holm 63
 ecology of *Margaritifera* in Ireland 267, 301
 ecology of *Monodonta lineata* 339
 ecology of *Parvicardium hauniense* 139
 ecology of slugs (book) 264
 ecology of Spanish land snails 365
 ecology of *Theodoxus* in Ireland 91
 ecology of *Vertigo lilljeborgi* in Wales 185
 ecology of *Vertigo moulinsiana*, *V. lilljeborgi* 186
 egg capsule of *Marginella eveleighi* 86
 England, *Monodonta lineata* 339
 England, *Myxas glutinosa* 39
 England, non-marine atlas 263
 England, Quaternary *Cochlicopa nitens* 215
 England, turrid records 341
 England, *Vertigo moulinsiana*, *V. lilljeborgi* 186
 English Channel, *Leptochiton scabridus* 117
 English Channel, *Monodonta lineata* 339
 English Channel, *Noemiamea dolioliformis* 258
 English Channel, turrid records 341
 English literature, fictional mollusca 1, 119
 Eocene fossils of New Zealand 265
 Europe, molluscs (book) 83
 Europe, NW, *Hydrobia* spp. 59
 Europe, NW, marine mollusc distrib. 83
 Europe, W, *Leiostyla* spp. 311
- feeding of *Acteon tornatilis* 143
 feeding of *Philinopsis cyanea* 199
 fictional mollusca, presidential address 1, 119
 Flat Holm island, land snails 63
 Folkestone, Quaternary *Cochlicopa nitens* 215
 Forcart, L., obituary 37
 fossil mollusca of New Zealand 265
 France, *Hydrobia neglecta* 59
 France, land snail records 259
 France, *Oxyloma sarsi* 395
 France, *Parvicardium hauniense* 139
 freshwater gastropods, Norway 397
 freshwater molluscs, Sierra Leone 31
 Freshwater Prosobranchs 345
 Fretter, V., obituary 337
- genetics of *Margaritifera durrovensis* 267
 genital anatomy of *Arion* spp. 385
 genital anatomy of *Catinella arenaria* 323
 genital anatomy of *Cochlicopa* 223
 genital anatomy of ***Coriocella hibyae*** 75
 genital anatomy of *Deroceras* spp. 382
 genital anatomy of *Furcopenis circularis* 383
 genital anatomy of ***Geomalacus malagensis*** 23
 genital anatomy of *Geomalacus* spp. 385
 genital anatomy of *Helicopsis conopsis* 52
 genital anatomy of *Helicopsis turcica* 52
 genital anatomy of *Lehmanna* spp. 384
 genital anatomy of *Letourneuxia* 28
 genital anatomy of *Liardetia sculpta* 171
 genital anatomy of *Limax* spp. 384
 genital anatomy of *Louisia barclayi* 171
 genital anatomy of *Milax gagates* 384
 genital anatomy of *Oestophora gasulli* 208

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

- genital anatomy of *Oxyloma pfeifferi* 323
- genital anatomy of *Parmacella* 381
- genital anatomy of ***Plentuisa vendia*** 161
- genital anatomy of *Rupestrella dupotetii* 354
- genital anatomy of *Suboestophora gasulli* 208
- genital anatomy of *Testacella maugei* 388
- genital anatomy of *Trochonanina gwendolinae* 180
- Gulf of California, *Pleurotoma piperata* 347
- Gulf of Guinea, marginellids 85
- Gulf of Lion, *Parvicardium hauniense* 139
- habitat of *Anodonta cygnea* in Ireland 394
- habitat of Norwegian freshwater gastropods 397
- habitat of *Parvicardium hauniense* 139
- habitat of *Theodoxus* in Ireland 91
- Hebrides, non-marine fauna of Ulva 175
- Heteroptera (Insecta), Cymatiinae homonymy 183
- Holocene, *Monodonta* in UK 339
- Iberian Cephalopda 343
- Iberian Peninsula, ***Geomalacus malagensis*** 19
- ICZN Case 2247, *Balea* 255
- ICZN Case 2526, *Strombiformis albus* 255
- ICZN Case 2634, *Xeromunda* 255
- ICZN Case 2710, Clavidae-Clavinae-Clavusinae 183
- ICZN Case 2766, *Conus* spp. 183
- ICZN Case 2801, *Potamolithus* 255
- ICZN Case 2820, *Turbo politus* 393
- ICZN Case 2833, *Tortaxis* and *Allopeas* 339
- ICZN Case 2838, *Pleurobranchus forskali* & *testudinarius* 393
- ICZN Case 2845, *Taningia danae* 339
- ICZN Opinion 1650, Cymatiinae homonymy 183
- ICZN Opinion 1651, *Mytilus anatinus*, *Anodonta anatina* 183
- ICZN Opinion 1677, *Haustator* 256
- ICZN Opinion 1678, *Helicarion* 256
- ICZN Opinion 1679, *Kobeltia* 256
- ICZN Opinion 1690, *Helix barbata* 339
- ICZN Opinion 1691, *Polygyra* 339
- ICZN Opinion 1699, *Conus fulmen*, *C.berghausi* 393
- ICZN Opinion 1700, *Laeocochlis* 393
- ICZN Opinion 1718, *Balea* 393
- ICZN Opinion 1719, *Xeromunda*, *Helix candiota* 393
- ICZN Opinion 1720, *Cycloceras laevigatum* 393
- ICZN Opinion 1721, Belemnitidae, *Belemnites*, *B.paxillosa* 393
- identification key, Portuguese slugs 377
- Indian Ocean, ***Coriocella hibyae*** 73
- Indian Ocean, estuarine bivalves 258
- Indian Ocean, *Philinopsis cyanea* 199
- Indian Ocean, ***Turbo jonathani*** 225
- Indian Ocean, ***Umbonium eloiseae*** 231
- Ireland, *Anodonta cygnea* habitat 394
- Ireland, *Assiminea grayana* 256
- Ireland, *Margaritifera margaritifera* 301
- Ireland *Noemiamea dolioliformis* 258
- Ireland *Pecten maximus* 41
- Ireland, River Nore, *Margaritifera durrovensis* 267
- Ireland, *Theodoxus fluviatilis* 91
- Irish Sea, 2 rare sea snails 117
- Isle of Wight, *Leptochiton scabridus* 117
- Isle of Wight, *Monodonta lineata* 339
- Isle of Scilly, *Codakia decussata* 116
- Israel, *Vallonia enniensis* 116
- jaw of ***Turbo jonathani*** 227
- Kent, *Noemiamea dolioliformis* 258
- Korea, *Pleurotoma piperata* 347
- Krus (von), H.C., *Conus* paintings 7
- land molluscs, Suffolk, UK 263
- land snails of Spain, ecology 365
- Layari River, Pakistan, bivalves 258
- Linnaeus, commissioning of *Conus* paintings 7
- Lowe, R.T., Maderian land snails, 1850s publication 116
- Madeira land snails, Lowe 1850s publication 116
- Madrid, land snail ecology 365
- Maldives, ***Coriocella hibyae*** 73
- Maldives, *Philinopsis cyanea* 199
- marine molluscs of Adriatic Sea 397
- marine molluscs of NW Europe 83
- Mascarene land snails in Tanzania 185
- Mazatlán, Mexico, *Pleurotoma piperata* 347
- Mediterranean, marine molluscs 397
- Mediterranean, *Parvicardium hauniense* 139
- Mexico, *Pleurotoma piperata* 347
- molluscs of Europe (book) 83
- Morocco, Aciculidae 357
- Morocco, *Helicopsis* spp. 47
- Morocco, land snail records 321
- Morocco, *Pupoides coenopictus* 149
- Morocco, *Rupestrella dupotetii* 351
- murex 5
- Museum of Queen Louisa Ulrica, *Conus* paintings 7
- mussels 4
- new species described by K.R. Smythe 243
- New Zealand, Eocene Mollusca 265
- Nguru Mts., Tanzania, *Moaria chaperiana?* 184
- Nigeria, *Ptychotrema aequatoriale* 71
- non-marine fauna, Ulva, Scotland 175
- non-marine mollusca of Australia 265
- Nore, River, Ireland, *Margaritifera durrovensis* 267
- Norway, freshwater gastropods 397
- obituary, of L. Forcart 37
- obituary, of V. Fretter 337
- obituary, of G. Osborn 246
- obituary, of K.R. Smythe 243
- octopus 2
- Oman, ***Turbo jonathani*** 225
- Oman, ***Umbonium eloiseae*** 231
- Osborn, G., obituary 246
- oyster 1
- paintings of *Conus* spp. plates (16–17)
- Pakistan, estuarine bivalves 258
- pearl 120
- polychaete, *Lanice conchilega* 143
- polychaeta, *Owenia fusiformis* 143

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

- polychaete, *Sabellaria alveolata* 118
- Portugal, land snail records 259
- Portugal, *Leiostryla* spp. 311
- Portugal, slug distrib. 389
- Portugal, slug identification key 377
- presidential address 1, 119
- prey species of *Philinopsis cyanea* 199
- Principe Island, marginellids 85

- Quaternary, *Cochlicopa nitens*, Folkestone 215
- Quaternary, *Pupoides* of N Africa 149

- radula of *Acteon tornatilis* 144
- radula of Acteonidae 145
- radula of *Chelyonotus semperia* plate (80–1)
- radula of *Coriocella hibyae* plate (809–1)
- radula of *Gibberula punctillum* plate (90–1)
- radula of *Plentuisa vendia* 164
- radula of *Trochonanina gwendolinae* plate (182–3)
- radula of *Turbo jonathani* 227
- radula of *Umbonium eloiseae* 234
- radula of *Umbonium vestiarium* 234
- radula of *Volvarina insulana* plate (90–1, 188)
- radula of *Volvarina riparia* 188
- Red Data Book, UK, non-marine 262
- Red Sea, *Philinopsis cyanea* 199
- reviews 83, 148, 261, 262, 263, 264, 265, 343, 344, 345, 397

- Sahara, *Pupoides coenopictus* 149
- São Tomé, marginellids 85
- scallop colour morphs 41
- Scotland, *Aclis gulsonae* 257
- Scotland, non-marine fauna of Ulva 175
- Sea of Japan, *Pleurotoma piperata* 347
- seashells (book) 148
- Seychelles, euconuloid land snails 169
- Shannon estuary, *Assiminea grayana* 256
- shell of *Acicula* spp. NW Africa 358
- shell of African *Pupoides* 150
- shell of *Anostoma octodentatum brunneum* 82
- shell of *Bulla ampulla* 203
- shell of *Caelatura aegyptica* plate (32–3)
- shell of *Chondrina farinesii granatensis* 353
- shell of *Cochlicopa lubrica* 216
- shell of *Cochlicopa lubricella* 216
- shell of *Cochlicopa nitens* 216
- shell of *Conus* plates (16–17)
- shell of *Coriocella hibyae* 75
- shell of *Cystiscus josephinae* 88
- shell of *Etheria elliptica* plate (32–3)
- shell of *Geomalacus malagensis* 23
- shell of *Helicopsis conopsis* plates (48–9)
- shell of *Helicopsis turcica* plates (48–9)
- shell of *Leiostryla anglica* 311
- shell of *Leiostryla numidica* 311
- shell of *Liardetia sculpta* plate (174–5)
- shell of *Louisia barclayi* 171, plate (174–5)
- shell of *Mangelia melanosticta* 348
- shell of *Margaritifera durrovensis* 267
- shell of *Marginella gemma* 87
- shell of *Mutela ovata* plate (32–3)
- shell of *Nassarina piperata* 348
- shell of *Oestophora gasulli* 207
- shell of *Parvicardium hauniense* 140
- shell of *Pecten maximus* 41
- shell of *Philinopsis cyanea* 201
- shell of *Platyla polita* 358
- shell of *Plentuisa vendia* 163
- shell of *Pleurotoma piperata* 348
- shell of *Prunum amphorale* 237
- shell of *Pupoides coenopictus* 150
- shell of *Ringicula* spp. 202
- shell of *Rupestrella dupotetii* 352
- shell of *Suboestophora gasulli* 207
- shell of *Trichia hispida* 166
- shell of *Trochonanina gwendolinae* 180
- shell of *Tropidophora calcarea* 334
- shell of *Turbo jonathani* 226
- shell of *Umbonium eloiseae* 233
- shell of *Volvarina ameliensis* 189
- shell of *Volvarina angolensis* 194
- shell of *Volvarina evanida* 192
- shell of *Volvarina fugax* 194
- shell of *Volvarina peregrina* 195
- shell of *Volvarina riparia* 193
- shell of *Volvarina* spp. 196
- Shropshire, *Vertigo moulinsiana*, *V. lilljeborgi* 186
- Sierra Leone, freshwater molluscs 31
- slug identification key, Portugal 377
- slugs 3
- slugs (book) 264
- Smythe, K.R., obituary 243
- soils, Spanish snail distrib. 365
- Spain, *Geomalacus malagensis* 19
- Spain, land snail ecology 365
- Spain, land snail records 259
- Spain, *Leiostryla* spp. 311
- Spain, *Oestophora gasulli* 205
- Spain, *Plentuisa vendia* 159
- Spain, *Rupestrella dupotetii* 351
- Spain, *Suboestophora gasulli* 205
- squid, giant 3, 121
- squid of British Isles *Sthenoteuthis pteropus* 125
- Suffolk, non-marine atlas 263

- Tanzania, *Maizania marsabitensis* 39
- Tanzania, *Moaria chaperiana*? 184
- Tanzania, *Trochonanina gwendolinae* 179
- Tanzania, *Tropidophora hanningtoni* 333
- Tanzania, *Tropidophora* spp. 185
- taxonomic nomenclature rulings 183, 255, 339, 393
- tentacle clubs of British squids 128

- UK, land snails of Flat Holm 63
- UK, marine molluscs 109, 249, 401
- UK, non-marine atlas, Suffolk 263
- UK, non-marine fauna of Ulva 175
- UK, non-marine molluscs 112, 249, 400
- UK, Red Data Book 262
- UK, *Theba pisana* 394
- UK, *Vertigo lilljeborgi* 185, 186

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

UK, *Vertigo moulinsiana* 186
 Ulva, Scotland, non-marine fauna 175
 Uppsala University, *Conus* spp. 7

vegetation associations of land snails 63
 vegetation associations of *Theba pisana* 394
 vegetation associations of *Vertigo lilljeborgi* 185

volutes (book) 344
 von Krus, H.C., *Conus* paintings 7

Wales, 2 rare sea snails 117
 Wales, land snails of Flat Holm 63
 Wales, *Vertigo lilljeborgi* 185
 walrus 1
 wentletrap 120

AUTHOR INDEX

Abbott, R. T. & Dance, S. P. 148
 Agüera, D., see Outeiro, A. *et al.* 365
 Aparicio, M. T., Seddon, M. B. & Holyoak, D. T. 47
 Arrébola Burgos, J. R. & Gittenberger, E. 351

Backhuys, W., see Økland, J. *et al.* 397
 Barnes, R. S. K. 59, 83
 Barton, J. H. 262
 Bebbington, A. & Turk, S. M. 115
 Begum, F. & Nazneen, S. 258
 Berthold, T. 345
 Biggs, J., see Walker, D. *et al.* 39
 Boyce, D. C., Holmes, P. R. & Read, D. K. 185
 Brown, K. J. T. 344
 Bruggen van, A. C. 71

Cameron, R. A. D. 186
 Chatfield, J. E. 83, 243, 246, 337
 Chesney, H. C. G., Oliver, P. G. & Davis, G. M. 267
 Clabby, K. J., see Lucey, J. *et al.* 91
 Coles, B. 263
 Colville, B. 256
 Cossignani, T., Cossignani, V., Di Nisio, A. & Passamonti, M. 397
 Cossignani, V., see Cossignani, T. *et al.* 397

Dance, S. P., Moolenbeek, R. G. & Dekker, H. 231
 Dance, S. P., see Abbott, R. T. *et al.* 148
 Dance, S. P., see Dekker, H. *et al.* 225
 Davies, S. M. 249, 399
 Davis, G. M., see Chesney, H. C. G. *et al.* 267
 de Souza Jr., P. J. S. 237
 Dekker, H., Moolenbeek, R. G. & Dance, S. P. 225
 Dekker, H., see Dance, S. P. *et al.* 231
 Devery, F. B., see Lucey, J. *et al.* 394
 Di Nisio, A., see Cossignani, T. *et al.* 397

Evans, J. G., see Young, M. S. *et al.* 63

Falkner, G., see Fechter, R. *et al.* 83
 Fechter, R. & Falkner, G. 83
 Fernandes, F. & Rolán, E. 85
 Fernandes, F., see Gofas, S. *et al.* 187
 Fogan, M. 1, 119

Gittenberger, E., see Arrébola Burgos, J. R. *et al.* 351
 Gofas, S. & Fernandes, F. 187
 Goto, Y., see Poppe, G. T. *et al.* 344

Heppell, D. 125
 Heppell, D., see Smith, S. M. *et al.* 261
 Hermida, J., see Rodriguez, T. *et al.* 377
 Holmes, P. R., see Boyce, D. C. *et al.* 185
 Holyoak, D. T., see Aparicio, M. T. *et al.* 47
 Holyoak, D. T., see Seddon, M. B. 321
 Holyoak, D. T., see Seddon, M. B. *et al.* 311
 Holyoak, D. T. & Seddon, M. B. 357

Kerney, M. P. 112, 253, 400
 Kilburn, R. N. 347
 Killeen, I. J. 108, 249, 258, 263, 397, 399
 Killeen, I. J., see Light, J. M. *et al.* 117
 Killeen, I. J. & Smith, S. M. 257
 Kohn, A. J. 7

Langley, J., see Walker, D. *et al.* 39
 Light, J. M. 252, 341, 343, 401
 Light, J. M. & Killeen, I. J. 117
 Long, D. C. 265
 Lucey, J. 301
 Lucey, J., McGarrigle, M. L. & Clabby, K. J. 91
 Lucey, J. & Devery, F. B. 394

Maxwell, P. A. 265
 McGarrigle, M. L., see Lucey, J. *et al.* 91
 Meier-Brook, C. 345
 Meredith, H. 394
 Mienis, H. K. 116
 Minchin, D. 41
 Moolenbeek, R. G., see Dance, S. P. *et al.* 231
 Moolenbeek, R. G., see Dekker, H. *et al.* 225
 Muñoz, B. & Parejo, C. 205

Nagel, K.-O. 31
 Naggs, F. 264
 Nazneen, S., see Begum, F. *et al.* 258
 Nisio (Di), A., see Cossignani, T. *et al.* 397
 Norris, A., see Wiktor, A., *et al.* 19

JOURNAL OF CONCHOLOGY, VOLUME 34, INDEX

- Økland, J. & Backhuys, W. 397
 Oliver, P. G., see Chesney, H. C. G. *et al.* 267
 Outeiro, A., Agüera, D. & Parejo, C. 365

 Parejo, C., see Muñoz, B. *et al.* 205
 Parejo, C., see Outeiro, A. *et al.* 365
 Passamonti, M., see Cossignani, T. *et al.* 397
 Paul, C. R. C. 175
 Poppe, G. T. & Goto, Y. 344
 Preece, R. C. 215, 339
 Prieto, C. E., see Puente, A. I. *et al.* 159
 Puente, A. I., & Prieto, C. E. 159

 Rands, E. B. 107
 Reed, D. K., see Boyce, D. C. *et al.* 185
 Rodriguez, T. & Hermida, J. 377
 Rolán, E., see Fernandes, F. *et al.* 85

 Sándor, E. 148
 Seaward, D. R. 83, 109, 261
 Seccombe, A. D. 109, 110, 250, 399
 Seddon, M. B. 149
 Seddon, M. B., Holyoak, D. T. & Tattersfield, P. 311
 Seddon, M. B., see Aparicio, M. T. *et al.* 47
 Seddon, M. B., see Holyoak, D. T. *et al.* 357
 Seddon, M. B. & Holyoak, D. T. 321
 Seddon, M. B. & Tattersfield, P. 259
 Sierra, A. G. 343

 Smith, B. J. 265
 Smith, S. M., see Killeen, I. J. *et al.* 257
 Smith, S. M. & Heppell, D. 261
 South, A. 264
 Souza de jr., P. J. S. 237
 Stevanovitch, C. 395

 Tattersfield, P., see Seddon, M. B. *et al.* 259, 311
 Turk, S. M. 115
 Turk, S. M., see Bebbington, A. *et al.* 115

 van Bruggen, A. C. 71
 Verdcourt, B. 37, 39, 81, 169, 179, 183, 184, 185, 333

 Walker, D., Whitely, D., Biggs, J., Langley, J., Whitfield, M. & Williams, P. 39
 Wellens, W. 73
 Whitely, D., see Walker, D. *et al.* 39
 Whitfield, M., see Walker, D. *et al.* 39
 Wiktor, A. & Norris, A. 19
 Williams, P., see Walker, D. *et al.* 39
 Willing, M. J. 262
 Wołowicz, M. 139
 Woodward, F. R. 103

 Yonow, N. 143, 199
 Young, M. S. & Evans, J. G. 63

HECKMAN
BINDERY INC.



JAN 98

Bound -To -Please® N. MANCHESTER,
INDIANA 46962

SMITHSONIAN INSTITUTION LIBRARIES



3 9088 00900 7402